EDUNET

Report of the Summer Study on Information Networks Conducted by the Interuniversity Communications Council (EDUCOM)

GEORGE W. BROWN • JAMES G. MILLER • THOMAS A. KEENAN

EDUNET

The time has come, say the authors, to take a giant step forward in American higher education. The step is to create an EDUNET, a revolutionary new system through which colleges and universities of all sizes and in all parts of the country can have quick access to information and can share their human, library and computer resources. Here, for the first time in book form, is a full report of the extent of need for such a system and a clear explanation of how it can work.

Can an advanced educational network using all media—from digital transmission to color television—make American higher education more efficient, more economical? Can it generally improve the quality of instruction and research? These are the central questions around which the case for EDUNET is built. The authors' answer—probably, let's find out—is based on a four-week conference of 181 educators and scientists in government, industry, medicine, and higher education. The conference, after exploring the many problems that would have to be overcome, arrived at an unexpected, almost unanimous consensus regarding EDUNET's feasibility and vast potential. The proposal set forth as a result of this agreement is discussed in the final chapter. It calls for action now on the part of educators, foundations, librarians, hospital officials, and government, plus members of the communications, publishing, and data processing industries.

This book is the first meaningful, comprehensive presentation of an EDUNET, and it should be of *vital interest to educators everywhere*. For that matter, as the authors have stated. "It would indeed be difficult to identify any social group that should not be concerned."

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EDUNET

Information Sciences Series

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EDUNET

REPORT OF THE SUMMER STUDY ON INFORMATION NETWORKS

Conducted by

THE INTERUNIVERSITY
COMMUNICATIONS COUNCIL

(EDUCOM)

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Information Sciences Series

Information is the essential ingredient in decision making. The need for improved information systems in recent years has been made critical by the steady growth in size and complexity of organizations and data.

This series is designed to include books that are concerned with various aspects of communicating, utilizing, and storing digital and graphic information. It will embrace a broad spectrum of topics, such as information system theory and design, man-machine relationships, language data processing, artificial intelligence, mechanization of library processes, non-numerical applications of digital computers, storage and retrieval, automatic publishing, command and control, information display, and so on.

Information science may someday be a profession in its own right. The aim of this series is to bring together the interdisciplinary core of knowledge that is apt to form its foundation. Through this consolidation, it is expected that the series will grow to become the focal point for professional education in this field.

Preface

Roughly one year after the activation of the EDUCOM Task Force on Information Networks a "Summer Study" was held in Boulder, Colorado. Perhaps the term "July Study" might have been more appropriate, but the descriptive term has survived from the time that a two-month study was contemplated. Final structuring of the study, at least with respect to matters of time, scale, and format, was achieved about two months in advance of the study itself; financial support was confirmed somewhat later.

Time pressures induced in the stage of detailed planning propagated themselves through the period of nearly four weeks, during which a substantial number of the 181 recorded participants talked and wrote, feverishly at times, about interuniversity information networks. Much of what they said has no doubt vanished; much was recorded, more or less imperfectly, in the working papers and daily summaries generated, typed, and distributed at Boulder. Even the favorite outdoor sport, that of porchsitting, was primarily dedicated to the subject matter of the study and contributed much to the development of ideas.

The organized chaos in which group activities took place was not designed to maximize the intellectual comfort of the membership, who accepted, perhaps with misgivings, but always with good grace, the sometimes improbable assignments which fell to them. The resulting flood of paper threatened at times to drown us all, writers and readers, talkers and listeners, and, of course, the long-suffering secretarial staff.

The report which follows constitutes an effort to convey the content of the tangible output of the Summer Study in a form which may serve a variety of purposes. The intent is not to produce a "Proceedings," either in the sense of a chronology of events and utterances, or in the sense of a collection of published articles, refereed and polished, each a self-contained jewel in the Temple of Learning. The aim is rather to produce a coherent analytic presentation of the ideas expressed, or some reliable facsimile thereof, always in the context of the goal of the study, which was to provide, if possible, a basis for the preparation of network proposals.

A word about style is in order. Except for a few paragraphs of the report, no attempt has been made to condense or abstract the raw material. In most cases the extracts used have been reproduced here, except for minor editing, as they were distributed at Boulder. By choosing selections from the materials available, arranging them in one of the many conceivable sequences, and linking them with brief narrative commentary, the editors have attempted to preserve the spirit in which the contributions were made and, at the same time, furnish the basis for relating the ideas to the larger picture. A certain amount of redundancy is unavoidable; certainly the report is overlong, as compared, say, with what might be accomplished by writing a report *de novo* based on the materials instead of quoting them.

Subjective biases will certainly appear, in the selection and arrangement of the material. Beyond that, quotations frequently appear without the context supplied by the author in his working paper. Although the individuals are cited by name, full responsibility must be borne by the editor, if meanings have been altered as a result of the extracting process. The other unpardonable sin of this report is its utter disregard of the matter of priority in the origin of the ideas. Earlier contributions which injected notions into the discussions are often not cited, when the ideas may have been built upon or refined by others. Sometimes the names of the original authors are mentioned, more often not.

It is difficult to acknowledge adequately the generous contributions of time and effort by the participants in the study. Their sincerity was always in evidence, their objectivity was surprising, and their devotion to the task almost beyond belief. The special contribution of a number of corporations, who sent representatives as participants and also contributed effort and equipment for the benefit of the study is particularly noteworthy. EDUCOM's debt to the universities and government agencies for their support, contributed in both human and financial resources, is clear. To Dr. Peter Regan and his staff, along with the staff at Boulder, many thanks for the cheerful and effective administrative effort supplied in the face of near catastrophe, including strikes and acts of God.

For their contributions to the preliminary draft version, grateful appreciation is due to Carle Hodge, who drafted Chapters 1 and 2 and furnished other valuable assistance; to

Joseph Becker, who wrote the initial draft of Chapter 7; and to J. C. R. Licklider, who made many contributions to the report. The manuscript has also benefitted from the patient final editing of Hilda Jones of the University of Pittsburgh and of Edison Montgomery.

George W. Brown
James G. Miller
Thomas A. Keenan

April 15, 1967

A Summary of ESS 66

In July 1966 some 180 individuals from educational, governmental, and industrial organizations assembled in Boulder, Colorado to assess the desirability of an educational communications system. The assessment entailed an identification of educational needs that might be satisfied, a survey of applications that would be feasible, a study of the organizational relationships implied by communications systems, and estimates of the scale, time schedules, budgets, and arrangements needed for the establishment of a useful educational information system. This assessment has laid the groundwork for a proposal for the next step in the admittedly complex process of developing an educational information system.

Even before the assessment of the desirability of an information network, it was considered important to survey the currently available networks and information resources. This survey helped to establish the reasonableness of network plans and to provide the platform from which further developments can arise. From the broad knowledge of the participants in the study, numerous existing networks were identified, some of which are beginning to take advantage of recent advances in information technology. In general, however, existing networks have been designed to serve a limited section of the total field that a national educational network might service. Many existing information networks provide service to a specific mission or to a specific discipline. The libraries of the country are the prime exception to this discipline orientation; but their service is generally quite restricted geographically; and the application of new technology to library service has, unfortunately, been slow. Newer information networks are appearing regionally but, as yet, these too are limited in subject matter.

Substantial collections of information that can be stored and processed by machine are already being assembled, some for the benefit of a particular project, some for availability within a geographic region. The participants in the study came to realize more than before that the ability to exchange information readily among the nation's information resources—making available to all the resources of all—without the constraints of geography, mission, or discipline is a most pressing need. Postponement in achieving this capability would not only encourage unnecessary duplication in the development of our information resources but also would make the eventual integration of these resources into a single network more difficult, as each limited program developed different standards, different techniques, and different procedures.

The colleges and universities in the United States would appear to provide a natural basis for a national information network because of their need for and dedication to the collection of knowledge in all fields of human endeavor. The growth in the amount of information available, coupled with growing numbers of students is making it increasingly difficult for colleges to have available local resources adequate to support a superior educational program. An effective information network has the potential of multiplying the effectiveness and efficiency of each professor. Moreover, an information network can do much to satisfy the needs for communication and access to information about research conducted in universities. Many examples were investigated during the Summer Study of information needs in the natural sciences, the social sciences, the humanities, the professions, and academic administration.

Having identified a lengthy list of specific needs and a large variety of possible network uses, the group turned its attention to the problem of how to establish the network that had been visualized. Organizational, administrative, and technical problems were identified. For some, particularly those of an organizational and administrative nature, different, and sometimes conflicting, proposals for solution were put forth. Although solutions were not obtained to all problems, it became clear that the technical resources for establishing a national information network do exist. It also became clear that the expectations of service and the demands that can be placed on such a network could be enormous.

On the technical side, certain questions of design philosophy, as well as questions of specific systems design, remain to be resolved. During the Summer Study, designs of both "star" and "round robin" networks were considered. The probability that the network would finally embody both of these philosophies was noted. The necessity of highly reliable performance dictates that an approach be chosen providing alternate communications linkages and processing facilities in the event of any equipment failure. The various communications media (e.g., digital signals, voice and facsimile messages, one- and two-way video) were extensively considered. Each medium presents its own difficulties in cost, time schedule, and technical and administrative problems. Nevertheless, a conviction emerged that the EDUCOM network (EDUNET) should set as its goal, the development of a true multimedia educational communications network on a national scale.

The Summer Study did not yield detailed specifications for either the hardware or software that will be needed, although valuable criteria that the hardware and software must meet were proposed and criticized.

The organizational and administrative problems that must be met in forming EDUNET will be large. Specifications and terms, on the basis of which facilities will be made available to colleges and universities, need to be established. Both federal and state agencies and commercial firms have much to offer to the network and much to gain from it, and the terms by which each can participate need to be defined. The information resources that are to be made available by means of the network have been and will continue to be developed by public and private institutions and by individuals. Means will have to be found through which the resources will become available to the network and the rights and privileges of all protected, including due compensation to the originator for the right to have access to material and its actual use and assurance that resources will be available only to those authorized to use them.

The EDUCOM Summer Study in 1966 did produce a recognition of the potential of a network for contributing to the satisfaction of a wide range of existing needs of institutions of higher education in instruction, research, and public service. It did clarify the present status of networks, the information resources available, and applications that could be implemented on a national network. It did crystallize the need for a coordinated approach to the establishment of standards and operating practices so that the growth of services that could be provided would be open-ended. It did develop a realization that many negotiations will be necessary to establish terms for access to the network and data in the network, for making hardware and software resources developed elsewhere available to the network, and for establishing the financial and regulatory environment in which EDUNET can become a self-sustaining and productive organization. Finally, it did illuminate the need for EDUNET to collect a talented, dedicated staff to design the network, to establish standards, and to undertake the necessary negotiations.

Based on recognition of what has been accomplished and what yet remains to be accomplished, a proposal has been prepared. It is presented as the final chapter of this report. Fundamentally, the proposal is directed toward the establishment of core staff to bring the necessary activities to the next level of accomplishment and to act as the prime nodes of the first pilot operating educational network. The beginning made in the EDUCOM Summer Study of 1966 and to be carried forward as envisioned in the proposal is considered to be a rational approach to the development of a capability that will have a substantial impact on American higher education. It offers a way toward removing many of the artificial barriers that tend to restrict the best education in our country to a limited number of "centers of excellence." The realization of the potential of EDUNET will entail many difficult choices, hard work, and imaginative support. This is an opportunity for judicious, yet creative, planning to reap rewards for generations of students to come. It is an opportunity to take a first step on the path leading to enhanced national competence in research and education with ever-widening implications for the future.

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1

Background and History of the Study

I. CHAPTER SUMMARY

This chapter is an introduction to the report, providing background on the timeliness of the information network concept and the questions for which answers are needed if network development is to proceed. It describes the founding of EDUCOM and its developing activities and, finally, records the planning for the Summer Study and the organization of the working groups, plenary sessions, etc., through which the study was carried out. The wide range of interests of the participants is noted. This study has provided one of those rare occasions at which people primarily interested in libraries and library science, people primarily interested in educational television, people primarily interested in information and computer science, and those with other specialized interests have applied their ideas and abilities to a common pursuit.

The chapter is made up of three main sections. The first section discusses the rationale for the study and raises several of the key problems for which answers are needed if information networks of the sort envisioned are to be established and operated. The second section reviews the history of EDUCOM and documents the sequence of steps through which EDUCOM was led to propose the Summer Study. The final section describes the planning of the study and the organization by means of which it was carried out.

II. RATIONALE FOR THE STUDY

Representatives of universities, government, industry, and private foundations, among others, gathered for four weeks during the summer of 1966 to clarify the idea of an interinstitutional information network—and to consider means by which such a network might become a reality. Arranged and administered by the Interuniversity Communications Council (EDUCOM) with financial assistance from several federal agencies, the EDUCOM Summer Study 66 met from July 5 through 29 at the University of Colorado in Boulder. Altogether, 181 persons (see Appendix A) devoted 1,475 man-days to the sessions.

Specifically, the study was convened to provide the basis for preparation of one or more proposals for the implementation of an operational interuniversity network. Further, it was geared to generate the discussions and working papers which formed the basis for this report, and, as a device for mutual enlightenment, to stimulate and inform participants with respect to the special interests and points of view of others taking part. The titles of working papers, as well as the preliminary papers prepared prior to the Study, are listed in Appendices C and D. Among the items considered were the desirability and feasibility of an information-processing system to link together various institutions, the applications it might offer, the availability of content material, rates, technical configurations, and the potential contributions to the grid of government, higher education, and other elements.

The scientific director of the Study, Professor George W. Brown, of the University of California at Los Angeles, set the tone of the study in an orientation session by a discussion of information networks, their history, their prospects, and their problems:

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G. Brown
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Basis for the existence of networks. Without attempting to define the notion of an information network explicitly, it is clear that various sorts of networks exist and some of them are very old. Nevertheless, if we confine our attention to an idealized super institution combining within it the functions of the library and the computer center, together with suitable formalizations of audio-visual departments and the other instructional media, we may consider what are the circumstances which would call for the establishment of networks which might interconnect information institutions, or subscribers with one or more information institutions or with one or more other subscribers, in any configuration whatsoever.

It was once seriously suggested that a single computer, centrally located, would be able to serve the entire computational requirements of this country by means of electrical communication with the dispersed users. At that time the practical computing capacity obtainable in a single installation was considerably underestimated, but the demands for service were far more seriously underestimated in the light of experience, which has shown how reinterpretation of the meaning of "computation" has taken place. At the time of the suggestion in question, the most serious obstacle to realization of the idea was the cost of the communications required, which resulted in modification of the idea to incorporate a small number of geographically distributed centers.

In more limited context the idea of regional computer centers still has considerable application, but the original simple notion is no longer current. Assume for the moment, however, that a single installation at a suitable location serves all demands for the digital processing of information; assume further that the installation is a super information center, storing all information conceivably useful to man, and available at low cost to suitable terminals located throughout the country. It appears unlikely that such a configuration would be stable, given

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any reasonable picture of a relationship between the cost of information processing, the size of the store in which random access must be made, and the costs of communication. Even in this ridiculous model of an information system it would be expected that various networks would appear as soon as individuals or organizations engaged in the activity of publishing on behalf of more or less well-defined communities of subscribers. Even if the entire communication process were constrained to take place through the center, the networks would still have logical existence. In consideration of everything that is known about our civilization, and, in particular, the academic community, the picture of a single center is completely unrealistic. Even so, the scholar is likely to be more concerned with the logical network, as it appears to him, than with the actual physical configuration.

To return to the question of circumstances which would call for the establishment of networks, let us agree to be concerned with physical networks, rather than purely logical ones. Using again the simple picture of an idealized, super information-facility, one should expect to find network connections in accordance with classical notions, such as the division of labor, whenever: (1) special collections for which one institution may be responsible may be useful to subscribers located elsewhere, through appropriate communications at appropriate costs; (2) local general collections are inadequate to meet a need which may be fulfilled elsewhere; (3) information storage or particular processing capability is centered in one location but economically useful elsewhere; (4) a collection may usefully be entrusted in portions to more than one location; and, of course, (5) whenever publication takes place, in the general sense indicated earlier. These notions are just as applicable to such elements of information as data bases and special processor programs as they are to books and documents.

Without attempting to carry these ideas further at the moment, it is interesting to consider, as a possible information network, the traditional radio or TV network, whether commercial or educational. While some of the essential elements are present, such a network constitutes a pretty weak information network in the sense of this discussion, by virtue of the generally passive

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posture of the audience (literally and figuratively) and the fairly rigid structuring of the materials broadcast. The second point in particular may account for the relatively small impact of TV so far on scholarship and higher education. It is reasonable to suppose that scholars require far more freedom to rearrange information, to interpolate, to reorganize, to edit, than the format has so far encouraged.

Key Problems. Nothing is easier to raise than problems, mostly very serious ones, in connection with the establishment and operation of information networks of the sort imagined here. A few key problems or problem areas are listed below, in no particular order:

1. What should be the basis for financial support, authorization to use, charges for use, allocation of resources?
2. What formal organization is required for network control, and how does it relate to university and institutional organizations?
3. How may the individual's freedom to organize his own activities through the network be ensured?
4. What kind and how much standardization and/or quality control is required of materials?
5. How will the legal questions of copyrights, liability, rates, etc., be resolved?
6. What should be the basis for evaluation of the operation of a network or its constituent elements?
7. What should be the interrelationship between private and public networks?
8. How may the methods or practices of the various media be generalized or transferred to the more inclusive context?
9. To what extent and in what manner should it be attempted to encourage or facilitate development of common data bases?
10. What role should the community play in the improvement of the system and its contents?
11. What should the role of EDUCOM be?

III. EDUCOM HISTORY AND ACTIVITIES

Founding of EDUCOM. The Interuniversity Communications Council, for which the short name is EDUCOM, comprised, at the time of the Boulder Study, 42 institutional members (Appendix D) in 23 states. Its purpose is to bring about collaboration among institutions of higher learning in their efforts to utilize the communications sciences. While all information-processing activities are of concern to the organization, the primary goals are to disseminate reports on the state of information handling techniques and to set up task forces to study areas of critical development. Basic research on the relative advantages of different modes of human communication will be encouraged and, eventually, the Council may cooperate with secondary and elementary schools in improving instruction.

Its formation, made possible by a $750,000, five-year Kellogg Foundation grant for administrative operations, grew from a belief that only through cooperation can the academic community make a major contribution to these new concepts and systems or derive the maximum benefits. In October 1964, a few days after the nonprofit Council (then known by the acronym INTERCOM) was incorporated in Michigan, six founding universities sent delegates to an initial meeting in Denver. Dean W. N. Hubbard, Jr. of the University of Michigan School of Medicine was elected chairman of the Council and treasurer. By the time the establishment of EDUCOM was publicly announced in mid-1965, there were eight charter members: Duke University, the State University of New York and the Universities of California, Illinois, Michigan, Pittsburgh, Rochester, and Virginia.

EDUCOM structure. Membership is open to every accredited college and university in the United States, Canada, and Mexico, but it is institutional rather than individual. Each member has one vote, *e.g.*, the nine-campus University of California is entitled to a single Council representative. Institutions pay $250 on admission and a like amount in annual dues, and each is encouraged to form an INTRACOM, an internal committee, to coordinate within its own institution all information-processing activities.

Routine policy matters and supervision are entrusted to a 16-man Board of Trustees, of which Dean William G. Anlyan of the Duke University School of Medicine is chairman. In June, Edison Montgomery, who had been vice chancellor for planning and general affairs at the University of Pittsburgh, was made president of EDUCOM. At the same time, Dr. James G. Miller, director of the Mental Health Research Institute, University of Michigan, who had been executive director of EDUCOM since its inception, became its principal scientist and vice president.

Early EDUCOM activities. In January 1966, the first issue of EDUCOM appeared. This nontechnical bulletin reports to faculty members of participant institutions on research, development, and academic applications in the information sciences. Among other topics, articles have been published on time-sharing computers, learning technology, and the use of computers in medical diagnosis. Articles in future issues will cover such subjects as computer-assisted instruction, educational television, and the utilization of computers in the humanities.

Internally, EDUCOM evaluates the emerging technologies as they affect all aspects of university activities—administration, teaching, and research. But EDUCOM visualizes its primary function as that of a voice of participant universities in relation to the other two major forces in our society, government and industry, in a continuing three-way dialogue regarding their relative roles in communications. Consequently, the Board and staff have devoted much effort to liaison with other agencies, private and public, to explore these potential ties. One result of such conversations was a three-day Conference on Educational Communications, held in April 1966 at Duke University.

About 150 educators, editors, copyright lawyers, librarians, publishers, and representatives of professional groups and government agencies attended the conference at Duke. In addition to discussions of the requirement for strengthened interrelationships--and the consensus was that the need exists—there were addresses on such matters as the impact on the health sciences of the new technologies and the possibilities of universal education by satellite.

Perhaps the most significant step yet taken by the Council has been the activation of task forces to focus the expertise already available within universities and colleges upon specific current problems in educational communications.

Task Forces. The announcement in 1965 of EDUCOM's birth summarized the task force philosophy in this manner: "It has become traditional for government and industry to improve their functioning by calling upon the competence and skills of scholars, irrespective of their institutional affiliations. It would seem desirable that universities and colleges take steps to avail themselves collectively of this resource."

Four such subgroups were, by the summer of 1966, busily fulfilling their assignments. One, on Educational Systems and Technology, is concerned chiefly with local or intracampus interfaces, the consoles, carrels, and other devices which will permit students to interact with educational materials (allowing professors to spend less time at routine teaching tasks). A Task Force on Legal and Related Matters is EDUCOM's legal advisory arm; it is analyzing the intricacies of copyright laws as they bear upon modern methods of storing and processing information. The Task Force on Computer-Based Systems for Clinical Activities evolved from the fact that so many member institutions have programs in the health sciences; it is studying the applications of new electronic techniques to the maintenance of patient records, patient care, diagnosis, toxicological data access, and laboratory automation. Additional working groups may be appointed for academic administration, continuing professional education, and other areas.

Because the idea of networks for sharing of resources is so central to the overall meaning of EDUCOM, however, the Task Force on Information Networks was the first to be established, with the expectation that the other Task Forces would feed into and interact with it.

Task Force on Information Networks. That group, chaired by Dr. George W. Brown of the Graduate School of Business Administration, University of California at Los Angeles, met initially in August 1965. The number and variety of recommendations for university-oriented information grids, regional and national, have mushroomed. The task force's mission is to evaluate them, to consider the state of the art, and, finally, to estimate how rapidly developments can be applied. One key, ultimately, to the utility of an interinstitutional network will be the automation of libraries, a goal toward which moves already have been made at the Library of Congress, M.I.T., and elsewhere. Not surprisingly, then, the Task Force on Information Networks includes librarians as well as computer scientists, educational TV specialists, and others (Appendix F).

The Task Force on Information Networks, in a series of meetings, developed a conviction that serious consideration should be given to the establishment of an educational information network. In the words of Dr. Brown:

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> They suggested that one or more networks be established in the near future to provide facilities which will further network applications currently feasible, to provide field operations within which the problems may be identified and solved, and to provide a basis for growth, which may well take place in directions not now anticipated. It was from the task force deliberations on this subject that the EDUCOM Summer Study 66 began to take shape.

IV. PLANNING FOR AND ORGANIZATION OF THE SUMMER STUDY

On behalf of Dr. Brown and his task force, Dr. Miller prepared and presented to the Board of Trustees in December 1965 an informal memorandum suggesting a summer study on information networks. His presentation pointed out the difficulty in determining whether a new network is technically feasible until such a system actually exists and can be tested. The trustees accepted the idea of a study, and they concurred with Dr. Miller's argument that because the time element was crucial the study should be scheduled in 1966. During the following several months, conversations took place with the appropriate granting agencies. The proposal was written and approved by the Board. Four federal agencies agreed, late in the spring, to fund the project. A joint grant was made by the National Science Foundation, National Library of Medicine, U. S. Office of Education, and the Public Health Service.

Dr. Miller was principal investigator under the terms of the grant, Professor Brown, the study's scientific director, and Dr. Peter F. Regan, the administrative director. (Dr. Regan is executive vice president, State University of New York at Buffalo.) After the University of Colorado consented to reserve housing and meeting rooms, the study was set for Boulder. A final pre-study planning session, arranged by Dr. Brown and Dr. Robert M. Hayes, associate director of the UCLA Institute of Library Research, was called in May in Los Angeles.

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Diversity of interests. Participants in the study represented a large number of different individual or institutional interests and were oriented in a variety of ways toward the underlying technologies which may advance those interests. Within the coarse classification according to institutional type—university, government, or industry—individual participants contributed many different points of view on information processing responsibilities, needs, and future possibilities. These points of view may be classified according to media, according to substance or content of a field of professional activity, according to techniques of use, or in other ways. The following unordered and far from inclusive list conveys some notion of the richness of the mix: libraries and library sciences, computer sciences, closed-circuit and broadcast radio and TV, communications engineering, audiovisual methods, educational research, health sciences, medical records, clinical operations, hospital administration, university administration, continuing education, computer-assisted instruction, documentation, data bases for information retrieval, science information systems, and selective dissemination of information. Technological progress is rapidly bringing us to the point where attitudes of specialists may have to be generalized, where integration of ideas must be considered,

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and where planning for the future may best ensure that the diversity of interests will be served.

Technical basis for correlation. The common interest of all participants was in information, most importantly in information as related to the individual—its generation and use—and in the storage, transformation, transmission, and display of information. The various media correspond to the multiplicity of forms available for the representation of information, each with its own implications for coding conventions, associated hardware, and requirements for software (in the language of the computer field) and each with its own implications for utilization by humans. Developments in the computer field, the communications field, and in peripheral areas related to both fields, have increased considerably the possibilities for useful transformations of information, translation between media, and interchange between individuals and information system and among individuals. For example, the development of computer technology, in the broad sense, has stimulated the application of revolutionary methods of information processing in areas which would have appeared to be most unlikely candidates for such treatment just a few years ago. The recent dramatic development of time-sharing systems has enhanced the ability of individuals to deal with computer systems interactively while other activities are being carried out through the same system, thus reducing considerably the cost of providing individuals with interactive facilities.

Communications developments will certainly reduce the cost of bandwidth in the future. In combination, these developments provide, at least in principle, the basis for hitherto inconceivable flexibility and versatility in information systems which may admit considerable freedom in the choice of media and enhanced potential for their use by educational and research personnel.

Study organization. The study agenda was so structured that "working groups" of participants, over the four weeks, considered successively: (1) needs, (2) applications, (3) institutional and organizational problems, and (4) network design. The format of the sessions purposely was kept flexible, and the composition of the working groups shifted often, to stimulate continuous interaction.

Approximately one week was devoted to each of the phases listed above although there was inevitable (and desirable) overlap in the topics considered in the four phases. A list of the working groups, their chairmen, and the charges to each is given in Appendix B and is summarized as follows:

PHASE I - DEFINITION OF NEEDS

I - Clinical Problems
II - Current Network Configurations
III - The Educational Process
IV - Library Needs
V - Network Concepts
VI - Current and Prospective Network Applications
VII - Technical Support

PHASE II - NETWORK APPLICATIONS

IV - Library Applications
V - Network Concepts
VII - Technical Support
VIII - Physical Sciences and Engineering
IX - Humanities
X - Social Sciences and Professional Schools other than Medicine
XI - Health Sciences Education and Research
XII - Health Services
XIII - Organizational and Institutional Context
XIV - Preparatory Network Proposal

PHASE III - ORGANIZATIONAL AND INSTITUTIONAL CONTEXT

VII - Technical Support
XIV - Network Design "A"
XV - Network Design "B"
XVI - Network Applications
XVII - Network Relationships, Control & Finance
XVIII - Relationships with Government, Industry, Professional Societies, and Foundations
XIX - Relationships with Libraries and Computer Centers

XX - Relationships with University Administrations
XXI - Relationships with Faculty and Students
XXII - Relationships with Health Sciences

PHASE IV - PREPARATION OF A SPECIFIC NETWORK PROPOSAL

XXIV - Communications Configurations
XXV - Nodal Configurations
XXVI - Operating Philosophy and Software
XXVII - Information Resource Sharing Applications
XXVIII - Instructional and/or Educational Service Applications
XXIX - Health Sciences Applications
XXX - Interinstitutional Problems
XXXI - Finance
XXXII - Gaps
XXXIII - Valedictory

To facilitate further the rapid exchange of experience, summaries of each working-group session were distributed to all participants the following day. These summaries were entered into an IBM ATS (Administrative Terminal System) for processing and for storage on tape for subsequent use. Also distributed, as quickly as they became available and could be duplicated, were the more than 150 working papers written during the study.

An advisory committee, established to give policy guidance to the directors and working-group chairmen, met at least once a day, and all representatives in attendance from federal agencies met at lunch weekly with Dr. Brown and Dr. Regan.

The study opened on 5 July with remarks of welcome and brief statements of purpose by the directors. Dr. Ward Darley, an EDUCOM founder and trustee and a former president of the University of Colorado, and Vice President Thurston E. Manning of the University of Colorado made introductory remarks.

Mr. Montgomery outlined the goals of EDUCOM. Then, Dr. Miller delivered the main address on interuniversity network needs.

On 29 July, the study closed with appropriate statements by the directors, a "valedictory" by Professor Allen Kent of the University of Pittsburgh, and a talk in which Dr. Miller gave his views of network potentials.

Exhibits and demonstrations were furnished by 16 commercial organizations; these companies are listed in Appendix G.

Plenary sessions. At the first plenary session on 6 July, the scientific director set the theme of the conference by specifying goals and working group objectives. A second plenary session was held on 8 July, at which Professor Arthur Miller addressed the conference on the legal implications of modern information technology; this was followed by a general discussion on Summer Study progress. On 13 July, the conference heard an address by Dr. Oliver Selfridge on user requirements and another by Dr. Darley on network problems in the clinical area. The fourth plenary session took place 15 July, with Joseph Becker as chairman; Dr. Samuel N. Alexander discussed preliminary proposals for an EDUCOM network. There were further plenary programs on 20 July and 22 July. Dr. Jacob Rabinow described the technology of photoelectric character reading on 20 July, and Professor Anthony Oettinger related classroom experience with on-line consoles in the teaching of mathematics. At the final plenary session, Dr. Don Mittleman summarized the working groups' deliberations on network applications; Dr. Eugene M. Grabbe compared the network-design proposals.

2

Current Configurations and Resources

I. CHAPTER SUMMARY

Chapter 2 is a review of the experience, facilities, and information that are currently available and provide the necessary resources for the successful implementation of a nationa information network. The first prerequisite considered is that networks are in existence, demonstrating that techniques and equipment are available and that considerable experience has already been accumulated in network design and operation. Existing university computer networks are identified, a number of other interesting analog and digital networks are described, and the existing educational television networks are discussed. Next, examples of several developing information systems are described in more detail. These examples further emphasize the point that the technology is available and that regional information networks are actually developing.

Services of the communications companies (common carriers) will clearly be important to an EDUCOM network. Therefore, the next consideration is a review of the common carriers and the services they provide. Finally, we consider the information that could be available through an EDUCOM network. The information resources appear to be substantial including digital (i.e., computer processable) and analog (i.e., television, voice, and experimental data) information. In many cases arrangements will need to be made concerning payment for the use of the information, and systems will need to be established for use authorization and accounting. These needs are taken for granted and not considered in this chapter.

II. CURRENT NETWORKS

Group II, working on current network configurations, recognized certain criteria as basic to an EDUCOM network, including the requirements for physical interconnection and organizational structure. Obviously, there would have to be both users with needs and content to fill the needs, but also there must be information transfer, computer-processable information, and nodes (e.g., campuses) and branches (e.g., transmission channels). Idealized, the network configurations would involve on-line operation, computerized central directory, and "conversational" means of access. Switching may be a defining feature of an EDUCOM network.

No such network exists at present. At least, none now exhibits all the main characteristics or provides all the principal facilities an EDUCOM system should have. Several existing or proposed grids, however, demonstrate component schemata that might prove useful. Current trends in on-line computing and in educational television networks are in directions somewhat parallel to the interests of EDUCOM, and the quantity of machine-readable materials and other resources is mounting rapidly.

University Computer Networks. A number of universities and university groups have established or are in the process of establishing communication networks. Brief descriptions of a number of these are given in Table 2-1. This table is known to be incomplete but was compiled as a beginning. Moreover, the descriptions are generally cryptic—intended only to indicate something of the state of development. Some of the networks are described more completely later.

Table 2-1. Selected University Networks

II Beck 7/15	1. Western Data Processing Center (WDPC), IBM and UCLA with 100 participating colleges and universities, including 15 with high-speed terminals. (a) UCLA campus and immediate environs, low-speed (15 cps) terminals. 18 terminals (1050) accessing the following systems: Remote Direct Couple System (DCS) (7094-7044) with (7740) for individual job processing—includes a file service for both programs and data; Computer-assigned instruction (CAI) (1410 with 7740); Quiktran, off campus at Los Angeles Data Center; Remote Access Computing System (RACS) 360/40 with 2702. (b) 15 university campuses in western third of U.S.: high-speed (250 cps) terminals, remote batch processing. Four of 15 are directly on-line to 7740 and DCS, remainder off-line to 7702. Approximately 85 additional campuses receive mail service only.
	2. M.I.T. (well publicized in the literature). Compatible Time Sharing System (CTSS) of Project MAC. Multi-language time sharing system access via 1050, teletype, etc. (160 terminals)
	3. Research Triangle, North Carolina. Four computers, two of which are now tied together. Colleges and universities in North Carolina will have computer access via teletype. (cf p. 24)
	4. University of California, Irvine. Currently, terminals (1050's) connected to a 1410 for CAI and JOSS. Planned for 1967 (around 360/50), a full range of university activities using terminals; including administration (student registration, finance, library, etc.), CAI, research and education.

Table 2-1—Continued

II Beck 7/15 Cont.	5. University of California, Berkeley. An estimated 12 terminals time sharing an SDS 940, using a JOSS type language and FORTRAN.
	6. Dartmouth. About 30 teletypes time sharing two G. E. computers, using a language called BASIC.
	7. Case Institute of Technology. Two Univac 1004 terminals into a Univac 1107, used by hospital and by students.
	8. University of Wisconsin. Fifteen on-line measuring devices into a CDC 924 which can interrupt a CDC 3600. A LINC (Laboratory Instrumentation Computer) is also tied to the CDC 3600.
	9. University of Utah. 12 or 14 terminals into a CDC 3200 in a university medical environment.
(added by C. Hodge)	10. State University of New York (SUNY). Statewide computerized network, starting with medical centers, is planned.
XXIV J. Miles 7/27	11. University of Florida. A leased microwave network, "Genysis," devoted entirely to graduate education, connects the University with Cape Kennedy and other space installations as well as several other Florida cities.
	12. Michigan Information System. A computer-based telecommunication system is to link the University of Michigan, Michigan State University, and Wayne State University—and ultimately other points within the state.

Other networks. The paucity of university networks is such that the application of even a moderately rigorous definition would exclude some examples that would have significance for EDUCOM. Hence, the flexible definition, and the decision to include in Table 2-2 selected examples from government and industry where there appears to be carry-over value. These examples should be evaluated in terms of network capabilities rather than current applications. Some applications have limited usefulness for EDUCOM (e.g., stolen car retrieval), yet the network may have significant characteristics. Potential usefulness rather than rigorous definition guided the choice of examples.

Table 2-2. Other Selected Networks

II Beck 7/15	1. JPL and NASA at Cal Tech. SFOF (Space Flight). This network ties tracking stations at Jodrell Banks, England; Canberra, Australia; Goldstone, California; etc., to a control center. It also transfers control to appropriate tracking station as a satellite orbits the earth. Data come in via a high frequency radio control system. Analog signals are digitized. Large data banks are generated.
	2. Montana Array. This network is used for detection of earthquakes and nuclear explosions by linking together 525 seismic detectors covering an area of 30 thousand square miles. Large quantities of information are sent to M.I.T. for processing. One reel of magnetic tape is generated every 10 minutes.
	3. Manned Space Flight Center, Houston. Multi-media. Voice, data, radio, etc. Wide band interconnection, Houston and Cape Kennedy.
	4. Autodin (Automatic Digital Networks). World-wide in scope, used by the U. S. government for defense purposes (Army, Navy, Air Force, NASA, DOD, etc.). Automatic switching—uses common carriers; also Autocon, uses voice network.
	5. New York State Intelligence System. Information sharing: interchange of information between state police; has store and forward facilities, message processing, etc.
	6. Alameda County in San Francisco Bay Area. Seven counties in Bay area have access to a real time system via remote terminals (1050's to 7740/7044). The function is to avoid duplication of files for outstanding warrants, lost vehicles, welfare applications, etc. (This system has been demonstrated in Europe via Telstar.)

Table 2-2—Continued

II Beck 7/15 Cont.	The system is also interconnected to the state capital at Sacramento to handle stolen vehicle reports. It is possible to access the Alameda system, have it check the Sacramento system, and give joint information back to the terminal calling Alameda.
	7. NAA (North American Aviation). Used for load-balancing via broad band microwave of multiple computers (7094's). Transmission is at the rate of 62 thousand ch/sec. The system is also accessible from non-computer sites, e.g., Edwards Air Force Base.
	8. Boeing. Plant data collection and control. On-line real time system—200 terminals. It is used for attendance records, production status, etc.
	9. United Service Automobile Insurance, Texas (contact Howard Gee, WRO-IBM, in Los Angeles). Computer control of policies in an insurance company. Keeps track of where a policy is as it is routed from department to department. Similar applications in other industries are in locating empty freight cars and in retrieving blueprints. The latter especially has security implications.
	10. International Industrial Library Network, IBM.
	11. Technical Information Retrieval Center, IBM. Information Retrieval and Library Service. Service includes announcement, retrospective searching, and current awareness dissemination.

The networks listed in Tables 2-1 and 2-2 by no means exhaust the networks now in operation. Each of the major airlines operates an information collection and reservation network. SABRE, operated by American Airlines, is the best known of these. Over a thousand reservation clerks throughout the United States can communicate by means of special typewriters with the SABRE headquarters at Briarcliff Manor, N. Y., and receive a reply within three seconds. Several of the railroads and pipeline companies operate their own communications networks some of which are digital. Many of the petroleum producers operate networks that automatically collect well production data and in some cases automatically control the flow and storage of oil according to the refinery requirements.

The Federal government operates a variety of information networks in addition to those already listed. Examples are the SAGE air defense system, the F.A.A. air traffic control system, the Veterans Administration medical records system, and weather data networks of the Environmental Services Administration. In addition to all of these, there are, of course, the common carriers—telephone, telegraph, etc.—and the commercial radio and television networks. The latter, mass dissemination networks, provide little feedback and are not interactive in the EDUCOM sense.

Educational Television. A number of organizations active in educational television operate networks. Those operating on a national scale rely on the mail to transmit their programs while those operating regionally have at least some electronic interconnection. Of course, the plans of some call for national electronic networks. The major activities were described in a working paper as follows:

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> 1. National.
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> a. National Educational Television (NET). Approximately 115 ETV stations throughout the country are affiliated with NET. At present, NET is not interconnected. Programs which are produced by NET and those which are produced for it are distributed to members on video tape or film via the mails. These programs (260 hours per year) are shipped from the NET duplicating center at Ann Arbor, Michigan. NET will conduct several interconnection demonstrations during 1967 in an

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attempt to illustrate the advantages of live networking over the present system of program distribution. The first of these demonstrations was a live broadcast of President Johnson's State of the Union Address in January 1967. This was a three hour program featuring analysis and commentary by political and government experts in different locations throughout the country. These demonstrations will provide invaluable network experience for NET and its affiliated stations prior to the establishment of a permanent, nationwide interconnected network.

b. Educational Television Stations/Program Service (ETS/PS). The television division of the National Association of Educational Broadcasters (NAEB) offers a limited program service, distributed by mail, to the majority of the ETV stations in the country. The programs are primarily the best programs produced by individual ETV stations which are freely contributed to ETS/PS for distribution to other stations upon request. There are no plans to interconnect.

c. National Center for School and College Television (NCSCT). This Center has, as its main function, the investigation, evaluation, acquisition, and distribution of instructional television materials to any interested user. It also strives to provide information concerning the status of and new developments in instructional TV throughout the country. Programs acquired by the Center are paid for, and users are charged a rental fee for materials ordered. At times the Center makes funds available for the enhancement of potentially good program series. This group has no plans, at present, for interconnection.

2. Regional.

a. Eastern Educational Network (EEN). This is a regional network of 22 ETV stations located in the 12 northeastern states and the District of Columbia. Distribution of programs is by mail and microwave. A private microwave system, owned and operated by the Maine State ETV Network, connects six stations in Boston; Durham, New Hampshire; and Augusta, Orono, Calais, and Presque Isle, Maine. Programs are contributed by member stations and made available to all stations. In addition, the network staff negotiates for and purchases

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programs from sources outside the network for distribution to members. A primary goal of the organization is to bring about full interconnection of all member stations in the region. An engineering survey has recently been completed which provides at least the preliminary information necessary for the construction of a privately owned and operated, two-way microwave interstate interconnection system. The system will extend from Washington, D. C., through Baltimore, Philadelphia, New York City, Hartford, Boston, Durham (N. H.), Burlington (Vermont), and end in Montreal. It will be a broad-band system capable of handling radio, television, and administrative functions. The system will have the technical capability of handling various kinds of data. The interstate system will interconnect the various intrastate systems now existing or being planned, thereby completing interconnection of all stations throughout the region. It is hoped that the interstate system (at least Washington, D. C. to Boston) will be completed sometine in 1967.

b. Midwest Educational Television Network (MET). The only other existing regional ETV network, MET has 10 member stations located in the seven northern plains states. Programs are contributed by member stations and distributed by mail. Interconnection has been agreed upon as a future goal, but no specific plans to interconnect are developed as of this date.

3. States. There are a number of states where interconnection either exists or is being installed:

a. Maine—private microwave—four stations.
b. Alabama—private microwave—six stations.
c. Delaware—leased, closed circuit, four channels.
d. Georgia—leased, 5 stations, 2 construction permits.
e. South Carolina—leased, 2 stations, 1 construction permit, and closed circuit TV.
f. Nebraska—leased, 3 stations.
g. North Carolina—private microwave, 2 stations.
h. Oregon—private microwave, 2 stations.

III. EXAMPLES OF DEVELOPING NETWORKS

Triangle Universities Computation Center. The Research Triangle in North Carolina has already been mentioned in

Table 2-1. It provides such an interesting example of interinstitutional cooperation, involving both public and private institutions, that a detailed description is offered here.

II
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In the spring of 1964 an Advisory Computer Committee to the North Carolina Board of Higher Education was established at the request of the state director of higher education. The membership of the committee is composed of representatives from Duke University, Durham, N. C.; University of North Carolina at Chapel Hill; North Carolina State University, Raleigh, N. C.; East Carolina College, Greenville, N. C.; and Agricultural and Technical College, Greensboro, N. C.

One of the recommendations of the committee was that the presidents of the Consolidated University of North Carolina and of Duke University study the feasibility of establishing a large computer facility in the Research Triangle area to serve the combined educational needs of the three major institutions in that area. All three of these institutions had outgrown their present computer systems and were faced with major expansions of computer facilities.

In mid-1965, a nonprofit corporation, the Triangle Universities Computation Center, was jointly established by the three institutions. This corporation is directed by a nine-man board of directors appointed from the three schools. Each institution agreed to guarantee one-third of the operating costs of the center. Partial support of initial operating cost was subsequently provided by a three-year NSF grant.

An IBM System/360, Model 75 was selected for the central computing facility. Various configurations of System 360, Model 30's will serve as the primary remote installations on the individual campuses. The first hardware delivery was made in February 1966 to the campus at Chapel Hill. In March an interim System/360, Model 40 was installed at Triangle Universities Computation Center. These initial installations are primarily intended for systems familiarization, program conversion, and development of communications hardware and software. These two initial installations were successfully connected by Telpak A* lines in June 1966, and a

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*For definitions of technical terms see Appendix H.

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Cont.

very limited remote batch-type processing system was initiated. Currently, the remaining two campuses are being added to this facility. A more sophisticated approach to remote computing is now being developed for this system. Many capabilities cannot be realized until the multitask versions of Operating System/360 and telecommunications modules of this system are available.

The System/360, Model 75 was scheduled for delivery in mid-September 1966. The initial configuration will include: 512 thousand bytes* of high-speed core; four-million bytes of extended low-speed core; five, 7.5 million byte disc systems; one, 400 million byte data cell; five magnetic tape drives; plus associated peripheral input/output devices.

Each campus has a number of low-speed (teletype) terminals and intermediate-speed (UNIVAC, DCT 2000, etc.) scheduled for installation in late 1966. These facilities must await future software developments and communication hardware modifications.

In parallel with the above developments, the Advisory Computer Committee has been developing plans to make the facilities at TUCC available to all institutions of higher learning. To this end, the committee has sought and obtained partial foundation and industrial support for what it terms the North Carolina Orientation Project. The project calls for locating, free of charge for one year, a low-speed remote unit in each institution desiring to participate. A director and staff of "circuit riders" are now being established to supervise the installation of and instruction in the usage of these remote terminals. Initial installations are scheduled to begin in January 1967 and should proceed at a rate of about six new installations per month. The final teletype network will include some seventy institutions throughout the state.

Other Communications Developments. Various states and groups of states are taking an increased interest in educational communications systems. Although some of these developments have already been mentioned briefly, the additional information provided in one of the working papers is considered valuable.

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*For definitions of technical terms see Appendix H.

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Educators throughout the country are becoming more and more aware of communications needs of institutions of higher learning. This is certainly evidenced by the fact that there is an EDUCOM active and working today. As further indication, it should be pointed out that many states and regions now have communications studies underway.

Indiana, under the guidance of Purdue University, has commissioned a 40 thousand dollar study that has just recently been completed by the consulting engineering firm of Jansky and Baily. This study, while it has particular applications and implications for Purdue, has involved the other three state-supported institutions from the outset and has concerned itself with the total needs of higher education within the state. Legislative action in 1967 is expected. Meanwhile, a 400 mile microwave system (Telco) will be in operation 1 January 1967.

The state system of higher education in the state of Oregon has similarly concerned itself over the years with the problem of communications. Currently a microwave network and many telephonic channels are operating between the seven institutions in the state system. Provision is made in the present network for inclusion of the private colleges of the state.

The state of Texas with the leadership of the University of Texas has recently started a study ($40,000) of the total needs for educational communications in that large state. The University of Texas has had for a number of years a U. S. Office of Education grant to operate what is known as the Texas Educational Microwave Project which currently connects approximately ten public, private, and parochial institutions in the Austin area. The privately owned microwave that they have built extends for some two hundred miles.

The states of Alabama, Georgia, Oklahoma, and North Carolina are all at some stage in the operation of state educational television networks which are also being used at some times for general communications purposes. The state of South Carolina has an extensive coaxial cable and broadcast network which interconnects the major public schools of the state as well as the various colleges and universities, both private and public.

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Cont.

There are similar activities in the states of Ohio (State ETV authority), Illinois, Minnesota ($150,000 legislative study grant), New York (SUNY office and committees), and the New England states, as well as Nebraska, Kansas, and California, where networks are either in partial operation or planned.

Meanwhile, the past decade has seen the development of the regional compact, a cooperative association of institutions of higher learning to seek solutions to common problems.

The Committee on Institutional Cooperation of the Big 10 and the University of Chicago (CIC), supported in large part by the Carnegie Foundation, now has nearly 50 working groups either engaged in or investigating cooperative action. Activity includes a Traveling Scholar Program, a water resources laboratory (federal grant), a Far Eastern language institute (federal grant), and the exchange of televised instructional materials.

The Southern Regional Education Board (SREB) started with a formal compact among 18 states to permit ready entrance of out-of-state students to professional and specialized schools. Today it has committees engaged in a full range of cooperative programs.

Other groups such as the Western Interstate Council for Higher Education (WICHE) have been formed and are actively functioning in many parts of the country.

IV. EDUCOM AND THE COMMON CARRIERS

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Where the term "common carrier" is used here, in the general sense, it means the American Telephone and Telegraph Co. (AT&T) and the associated Bell System operating companies, General Telephone & Electronics Corporation (GT&E) and the associated General System operating companies, the various other 2,400 independent telephone companies, and the Western Union Telegraph Company (W.U.).

In general, the same or similar services are available from each telephone company. The independent telephone companies are either concurring, connecting, or participating "carriers" in the various AT&T Company FCC Tariffs (132,260, etc.) in providing interstate service. Working agreements between AT&T, GT&E, and the independents in the provision of service have been in

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Cont.

existence for years and, in effect, when one deals with one specific telephone company, he is dealing with most, if not all, of the telephone companies involved. Individual company policy procedures and rate structures may differ somewhat, but they are essentially the same insofar as interstate services are concerned.

Although the independent telephone companies may use equipment that is different from The Western Electric Company equipment in general use by the Bell System, end-to-end compatability and continuity of service exist throughout the industry.

The intent here is to outline the basic services available from the telephone "common carriers." It should be kept in mind that certain voice, data, broadband and video services are also available from the Western Union Telegraph Company. Interworking agreements generally exist between Western Union and the various telephone companies.

Nearly all of the services of a telephone company are provided under tariffs filed with state regulatory commissions or the FCC. The exceptions are certain non-common carrier services, provided by certain telephone companies under contract to the user—such as sound systems, intercommunicating systems, and private mobile radio systems.

The services provided under tariff are broadly categorized as local exchange, general exchange, private line, toll, and mobile. Basic telephone rates for business and residential services are the scope of the local exchange tariff.

In the general exchange category are the many items of service and equipment which supplement basic service. These run the gamut from extension telephones to the most complex private branch exchange arrangements, and include automatic answering and recording equipment and data communications equipment.

The private-line services are often referred to as leased-wire services. A private line is generally a full-time circuit and may be across town or across the country. There are various grades of private-line circuits depending on the type of intelligence to be transmitted. Teletypewriter grade covers low-speed data as well as the familiar teletypewriter communications. Next is telephone grade, used for voice communications, facsimile,

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and medium speed data-transmission applications. Program-transmission circuits are used for carrying audio signals for radio broadcasting. These circuits have a greater audio frequency range than those designated telephone grade. Television signals for broadcast or closed-circuit use are carried by video circuits. More recently, telephone companies have been offering channels for use by Community Antenna TV companies in distributing TV signals for home receivers. The use of private-line services in educational communications is increasing tremendously, in assisting institutions to share computers in remote teaching projects, in libraries, in language labs, in educational TV, and in many other areas.

Toll service, of course, refers to the familiar long-distance message service but also includes wide area telephone service which permits unlimited long-distance calling for a flat monthly rate.

Mobile service extends telephone service to vehicles. Recent developments in this area have made mobile service comparable with regular service. It is now offered in many areas on a two-way dial basis. In these areas the "push to talk" button to transmit from the vehicle is no longer required.

This has been a very brief outline of the scope of tariffs. For detailed information and rates applicable to interstate private line services, a copy of Tariff FCC 260 issued by AT&T is available in the general office of every telephone company. Western Union tariffs are available at major offices of Western Union.

Communications services that will be of interest to EDUCOM are discussed more thoroughly in Chapter 6 and in Appendix H. These include both analog and digital services. Table 2-3 lists the standard communications services available from the common carriers. Caution should be exercised in interpreting an over-simplified table such as this. Communications engineers should be consulted concerning the possible subdivision and other specialization of communication links. For example, the bandwidth of a link is a measure of the amount of analog information that can be transmitted and also measures the maximum amount of digital information that can be sent over the link. However, the digital capacity is generally limited by the data sets at each end of the link and a growing variety of data sets are becoming available. Moreover, a service shown in Table 2-3 can be subdivided in a number of ways. A voice grade circuit can be used to service either four digital terminals at 150 bits per second each, or it can be used to service twelve digital terminals at 75 bits per second each. Despite these complications, Table 2-3 is offered as a simple categorization of available services.

Table 2-3. Available Communications Services*

Service	Bandwidth	Bit Rate
Low speed digital (Teletype)		75 bits/sec 150 bits/sec = 14.8 char sec
Voice grade	4 kc	up to 2000 bits/sec on usual dial network up to 2400 bits/sec on private lines
Telpak A	48 kc	up to 40.8 kbits/sec with model 301 data set
Telpak B†	96 kc	
Telpak C	240 kc	approximately 100 kbits/sec
Telpak D	1 mc	approximately 500 kbits/sec
"Half video"	2 mc	
Video	4.5 mc	

*All data are to be considered as nominal.
†Telpak B services have recently been withdrawn.

Table 2-3—Continued

Service	Bandwidth	Bit Rate
T-1 carrier		1.5 mbits/sec within campus not a long distance service at least for the near future
T-2 carrier		6 mbits/sec
T-4 carrier		220 mbits/sec—some time in the future

V. INFORMATION RESOURCES FOR A NETWORK

There is already in existence a large amount of computer processable data. In addition, there are numerous libraries and information centers producing computerized text, indices, and citation lists. Much of this material will be available to an EDUCOM network. Examples of such information center activities follow:

II
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Hersey
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1. Federal systems.

a. Science Information Exchange, administered by the Smithsonian Institution and supported by the National Science Foundation, organizes and disseminates information about scientific research, chiefly in the natural and physical sciences. It focuses on the prepublication phase, primarily to avoid unwarranted duplication of research effort. After analysis, indexing, and processing, 200-word technical summaries are stored in a computer for quick retrieval.

b. National Library of Medicine, U. S. Public Health Service, collects and disseminates information important in medicine and public health. As the largest biomedical library, NLM has the responsibility of comprehensively indexing the world's literature in medicine and biology. Its computerized MEDLARS (Medical Literature Analysis and Retrieval System) is utilized in preparing the monthly Index Medicus as well as in providing recurring and demand bibliographies.

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Cont.

c. National Referral Center, administered by the Library of Congress but supported by NSF, might be described as a "switching center" among information centers. It neither provides bibliographies nor answers technical questions directly; rather, it refers people making requests to other agencies.

d. Clearinghouse for Federal Scientific and Technical Information (CFSTI) distributes for public sale a pool of unclassified reports that result from federally funded research, in addition to a translations announcement journal, a supporting index to available government reports, and abstracts on perforated tape.

e. Educational Research Information Centers (ERIC), U. S. Office of Education. Twelve individual centers, most of which are at universities, will collect, index, and provide ERIC Central with 250-word abstracts of papers in their fields, with significant citation information cut on flexowriter tape. Through central processing, the more significant of the collected papers will be made available in Washington.

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f. National Agricultural Library, Department of Agriculture, acquires, maintains, and disseminates information on agriculture and related sciences. The Library also coordinates all scientific and technical information activities of the Department. Its Task Force ABLE (Agricultural-Biological Literature Exploitation) issued, in March 1965, a report that analyzed Library functions and recommended that it move toward automation. An Agricultural Vocabulary Project is preparing a basic authoritative agricultural/biological vocabulary for information storage and retrieval. The monthly Bibliography of Agriculture now is issued by using an optical scanner-computer combination.

2. Non-federal, nonprofit.
   a. Chemical Abstracts.
   b. Biological Abstracts.
   c. Excerpta Medica.

3. Non-federal, profit.
   a. Institute for Scientific Information (Philadelphia).

More than two dozen sources of machine-readable information were identified at the Summer Study. A questionnaire was sent to each to determine the form and amount of information available and whether arrangements could be made to make the information available to EDUNET. Sixteen responses were received, all of which indicated a willingness to permit the use of their materials by EDUNET. A list of these potential sources is given below with an asterisk indicating those from which a cooperative response was received.

*American Chemical Society (Chemical Abstracts Service)
*American Society of Metals (Metallurgical Information)
American Psychological Association (Abstracts)
*Association of American Medical Colleges (Health Professions Records Exchange)
*University of California at Los Angeles Brain Research Institute (Brain Information Service)
Universities of California, Michigan, Michigan State, Rochester, and Tulane (Simulations of university functions)
*Columbia University Center on Parkinson's Disease
*Defense Intelligence Agency
*Encyclopedia Britannica
Exerpta Medica Foundation
*Interuniversity Consortium for Political Research
*Johns Hopkins University Human Communications Information Center
*Library of Congress (Current catalog materials)
Massachusetts Eye and Ear Infirmary Vision Information Service
*Massachusetts Institute of Technology Technical Information Project (TIP, citations to Physical Review)
*National Library of Medicine (MEDLARS and current catalog materials)
National Institutes of Health (Administrative and other materials relative to NIH grants)
National Institute of Mental Health (National Clearinghouse for Mental Health Information)
University of Oregon Primate Center (Animal behavior and nutrition records)
University of Pittsburgh Health Law Center (Legal text)
*Rand Corporation (Translations of Russian documents)
*Science Information Exchange

*Tulane University (MENU, Hospital Menu Planning Project)
United States Office of Education (ERIC, Educational Research Information Centers)
*Wayne State University (CAST, Current Awareness Service for Selective Dissemination of Academic Administration Information)

It is important to note that the above list of potential sources of machine-readable information is by no means complete. The list was compiled hurriedly, the survey was distributed hurriedly, and the responses recorded are only those that were returned promptly. Each respondent was asked to estimate the amount of information that would be available in January 1967, January 1968, January 1970, and January 1975. Even though not all the respondents offered such estimates, the result is impressive. Table 2-4 gives the dates, the number of estimates, and the total amount of information estimated.

Table 2-4. Information Available

Year	Responses	Amount of Information
1967	14	1.3×10^8 characters + 2×10^5 documents + 1.2×10^3 citations + "large quantities of full text"
1968	11	1.3×10^9 characters + 2.2×10^5 documents + 7×10^4 citations
1970	7	2.4×10^9 characters + 3×10^5 documents
1975	7	1.5×10^{10} characters + 5×10^5 documents

A second questionnaire was sent, on June 13th, to the EDUCOM institutional representatives to determine whether each University would want to have a network terminal, the reasons for their interest, and the information resources that could be made available. As of July 22nd, 27 replies had been received from universities having a total of 169 campuses. Of these 22 reported a definite desire to have a network terminal, 5 said that such a decision would have to be made later or did not answer the question, but no one stated they would not want a terminal. The universities responding are listed in Table 2-5 with an asterisk indicating a definite interest in having a network terminal.

Table 2-5. Universities Responding to Survey

Alabama, University of
*California, University of
Cleveland State University
*Florida State University
*Indiana University
*Iowa, University of
Kansas, University of
*Kent State University
*Lehigh University
*Marquette University
*Miami, University of
*Michigan State University
*Michigan, University of
*Missouri, University of
*New York, State University of
*Northwestern University
*Notre Dame, University of
Oregon, University of
*Pennsylvania, University of
Pennsylvania State University
*Pittsburgh, University of
*Purdue University
*Texas A & M University
*Tulane University
*Washington, University of
*Wayne State University
*Virginia, University of

The reasons given for wanting a network terminal were varied. They included, among others, the desire to obtain more effective communications with other universities; to use specialized teaching talent at other institutions; to have access to specialized library resources; to share computer facilities; to interconnect with planned or existing internal networks and statewide networks; to have a means of studying file organization, executive routines, interface problems, systems compatability, query constraints and other important problems in the information sciences; and to be able to introduce locally generated information into a national distribution system. A number of replies indicated that the institutional plans are based on the concept of dispersed teaching locations connected by an information network. Interconnection with a national information network is viewed as desirable so that existing experiments and experiences can be related to the nationwide picture.

The universities indicated that a large body of information beyond that already discussed exists and could be made available. Selected responses are given below:

> Alabama, University of: "If it chose to do so, a great many kinds on either magnetic tapes or punch cards (nothing on punched tape). For example, the Office of Student Records has much data on students on cards. The Bureau of Business Research has retail sales on cards as well as data from a fairly large number of other studies. The social science departments (especially sociology and psychology) have programs and data on card and/or magnetic tapes. The University Computing Center, of course, would

be the primary source of numerous programs of all kinds as well as data cards and magnetic tapes."

Florida State University: "This is a very difficult question to answer until copyright regulations become clarified. Much of the computerized wholesale text that is on file is subject to control by the author or copyright holder which may drastically limit its availability as network input. However, in general, material developed at FSU will be made available to the network on a free-use basis. Certainly, program libraries from the computer center, demonstration programs from Project Tact, data bases prepared for our own School of Library Science and locally generated tapes of literature in the public domain will be freely shared with the network. When our dual font scanner becomes available in 1967, input should become available."

Lehigh University: "(a) Bibliographic reference retrieval system in the information sciences; (b) Natural language text (ca. 100,000 words) in the information sciences; programs now in development phase for statistical and syntactic analysis of this text; (c) Computer programs for data manipulation in science and engineering; (d) we hope in the next twelve months to develop a title searching system for reports of Congressional hearings."

Marquette University: "Data obtained in research, especially in medicine and bio-medical engineering; in physics, sociology, psychology, and education—assuming the data gathered by researchers at this University are of value to others. From a different point of view—keypunched information, information on magnetic tape, and data read by an optical scanner."

Miami, University of: "1. Source materials and research abstracts in specific subjects. 2. Listings of available material in all libraries (Main, Marine Science, Engineering and Medical)."

Pittsburgh, University of: "(a) Crystallography (b) foreign science and technology—one of a kind file, oral permission has been granted. (c) aerospace (d) hematology (e) health law (f) drug prescriptions (c through f subject to permission being granted)."

Purdue University: "I take it that audio and video tapes qualify as 'machine-readable'; and, if so, then the University has a considerable library of both, plus the continuing output of both a radio station and an instructional television unit. Student records and class schedules are all computer processed. As mentioned earlier, all records of the University Libraries' holdings of serial (periodical) publications are being developed and will be maintained by computer processing. This project is now in the immediate preoperational phase. Computer systems serving other functions in the Libraries are under development."

Texas A&M University: "Attached sheets contain a brief description of information of various types that is located around the A&M campus or can be obtained by persons on campus. This list was collected hurriedly and is incomplete. A comprehensive inventory of this type is underway and will have additional items as well as more information on entries already included.

"We may also be able to release information, programs and procedures used in the operation of the University such as registration, payroll, inventory control, billing, budget, etc., to other colleges and universities interested in implementing similar systems.

(Attached information as follows)

"1. Course descriptions of all courses taught at Texas A&M. This is the normal type information as found in a university catalog.

"2. Research activities inventory containing research and management information on all projects controlled by Texas A&M will be available within the next year.

"3. Concordance data on several works of prose currently available and extensive work in concordance is to be accomplished within the next year.

"4. Bibliography data in chemistry on hydrocarbons, organic, heavy chemicals, etc., dealing mainly with chemical thermodynamic properties, with 15,000 to 20,000 entries to be available within the next year and a half.

"5. Calculated ideal thermodynamic properties from basic data such as density, refractive indices, etc., on methanes, ethanes, and other compounds.

"6. Ionospheric data and calculated summaries from information collected by satellites.

"7. Antennae programs collection dealing with mutual impedance, self-impedance, field patterns, etc.

*"8. Weather data from 45 locations around Texas with daily readings indicating temperatures, humidities, wind movements, evaporation data, etc., collected since 1960.

*"9. Banking system weekly data for the United States back to 1947 and monthly back to 1919 concerning money supplies, deposits, reserves, etc.

*"10. Social, political, and economic data for 1962 for 48 states with information such as population densities, enrollments in schools by types, apportionment indices, political competition indices, etc.

*"11. Labor force characteristics for 48 states for 1962 dealing with civilian labor force, total labor force, etc.

*"12. Grain transportation data for Texas in 1964 concerned with the amount of grain shipped and modes of transportation within the State of Texas and other states.

†"13. Feed and fertilizer control and service data such as quality control samples, products registered, mailing lists and amounts sold in Texas since 1961.

†"14. Soil conservation needs data for nine states contains data pertaining to inventory of soil by sampling, uses and capabilities of land.

†"15. Texas Forest Service--forest fire reports for Texas concerning causes of fire, people involved, etc., since 1962.

†"16. Texas Forest Service--continuous forest inventory with data on timber value, index of growth, etc.; first data collection began in 1960.

†"17. Criminology statistics involving persons convicted of homicide or rape. Data collected by Dr. R. C. Koeninger of Texas Southern University. This information was obtained on deathrow in Huntsville State Prison in Texas.

†"18. Cattle breed records from McGregor, Texas, since 1956.

†"19. Slaughter and cutting data on cattle since 1961 and sheep since 1964, all information collected at A&M campus.

†"20. Consumer preference surveys on various products collected by the Agriculture Economics Department of Texas A&M.

†"21. Environmental air and sea data for the Gulf of Mexico concerning time periods, water temperature, wind velocity, etc., collected since 1962 from three stations on and near the coasts of Florida.

†"22. Space and land use data from Waco, Texas, for 1964 dealing with various uses of land such as commercial or residential.

†"23. Transportation network origin and destination survey data from Waco, Texas, for 1964 dealing with traffic generation zones in 24 hour periods.

†"24. Entrance and exit data from the Gulf Freeway in Houston, Texas, for 1965-66 utilizing metering studies and abbreviated origin and destination data.

†"25. Traffic study data relating to motor carrier operations within the southwestern region of the United States. Data collection is continuous since 1965.

†"26. Industrial location data relative to industries locating along the interstate highway system of Texas. Data collection began in January 1964.

†"27. Property and land value changes in Texas due to changes in access to the property. Study to be completed within the next year.

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*Information which may involve cost.
†Information which may require permission of a sponsor."

Wayne State University: "1. SDI program information in field of higher education. 2. Wide range of scientific and technical information through multi-phased work of CAST. Several KWIC indexes now available. 3. Educational research data in field of culturally disadvantaged (KWIC index to literature now available)."

Virginia, University of: "The University's Computer Science Center has extensive language capabilities including ALGOL, COBAL, LISP, DYNAMO, FORTRAN II, and FORTRAN IV, and, in addition, ALGOL, COBAL, and INTERP for remote console use. Machine readable data immediately available include:

"1. The complete texts of the French poet Racine on magnetic tape for concordance generation, etc.

"2. Text of *Morte d'Artur*.

"3. Bibliographic data covering monographs and conference literature of aerospace interest; deep indexed; currently 3000 volumes; 60,000 terms.

"4. Regional tumor registry, NCI format, 13,500 cases.

"5. Intensive Care Unit. Patient monitoring data at various levels of reduction.

"Early response suggests that the following may also be made available:

"1. COMSEARCH—index of all reported opinions of the United States Court of Appeals for the Fourth Circuit (1881-1966) involving Habeas Corpus (owner—The Michie Co.; Charlottesville, Virgnia).

"2. Distribution of the Defense Document Center catalog service; contains 300,000 subject entries (pending selection of UV as a center)."

3

Identification of Needs

I. CHAPTER SUMMARY

Problems that would be solved and needs that would be met by an EDUCOM-style network are identified and discusse in this chapter. Since needs can only be identified by evaluating potential applications, there is an inevitable overlap between this chapter and the next, on applications.

To understand the needs felt by the participants, it is important to consider who came to the conference at Boulder and to try to evaluate why they came. This is the intent of section II of the chapter.

Section III provides an introductory summary of the needs that might be satisfied. This summary first provides a characterization of EDUNET and then briefly discusses advantages of such a network in providing general accessibility for document and information retrieval, the pooling of programs, and the central processing of data. Examples of needs are cited in library functions, in clinical activities, and in political science.

Section IV discusses, at greater length, needs that are felt by every college and university today that EDUNET might satisfy. Among these are needs induced by the pressures of the increasing student population, the increasing demand for quality education, a declining productivity of the faculty (in terms of degrees granted per faculty member), and increasing demands for governmental and community services. It is argued that a communications network can satisfy needs both in teaching and in research and needs are discussed in the social sciences, academic administration, mathematics, and the humanities.

In section V we specifically introduce a concept that is central to EDUNET, that of sharing. The point is made that there are many things to be shared and many advantages to be gained by all through sharing.

Sections VI and VII are specifically directed to the needs that EDUNET can satisfy in the functions of libraries and the health sciences. We find each of these, although situated in the university community, to have somewhat different needs from the community generally. We also find that EDUNET could be beneficial to these areas.

II. WHY PEOPLE CAME TO BOULDER

To begin the study of needs it is reasonable to ask why the people who participated in the Summer Study devoted their time and energy to the program. While many motives undoubtedly exist related to the institution the person represents, his position, his experience, etc., we believe that a common denominator is that all felt that needs exist which possibly could be met by an EDUCOM network. The first clues to these needs can be found by inspecting the list of participants (Appendix A) and their objectives.

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It may be obvious that the objectives of all those who attended the study conference are not identical. This should not be surprising, since eight different types of individuals were identified, as follows:

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Cont.

1. Representatives of educational institutions that constitute EDUCOM as it now exists.
2. Representatives of institutions, agencies, and industries that might relate to EDUCOM as it might become.
3. Representatives of governmental agencies that might wish to use EDUCOM to aid in accomplishing their individual or collective missions.
4. Representatives of governmental agencies and foundations that might wish to consider helping to finance the development of EDUCOM activities.
5. Representatives of government, industry, or other nonmembers of EDUCOM who are interested in helping to design and put into operation the communication system (or information network) that was the subject of discussion during this study conference.
6. Representatives of EDUCOM—the corporation—who are seeking a proper and productive role for the newly formed organization.
7. Representatives of the EDUCOM Task Force on Information Networks who are seeking to improve and test their hypotheses.
8. Observers who came merely to look and listen.

It is clear that two sets of institutions, the universities and the government agencies, are of primary importance in relation to the characterization of needs. The traditional roles of the university are represented by a set of activities which include the use of information systems in the classroom, in the laboratory, and in research; the counseling of students and other student services which rely on the availability of appropriate information; administrative services dependent on the adequacy of current and historical information; continuing education activities in which the university acts as an information channel to professionals and others; and broadly speaking, in making information services available to the public.

Specific objectives of the representatives of EDUCOM member institutions may have depended upon:

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1. Their previous exposure to EDUCOM, its philosophies, and its activities.
2. The amount of their involvement in EDUCOM task force activity.
3. The extent to which their institutions have undertaken "intracom" activities.
4. The nature and extent of their involvement in community service and research programs, and in programs involving modern educational technology.
5. The magnitude of the shortage in teaching staff and/or facilities.
6. The size of their cumulative budget deficit.

Objectives of some of the government agencies represented at the Summer Study have been articulated as follows:

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The annual national budgets for education and health services approximate $40 billion* each; a mechanism, e.g., a communication system or information network, which shows promise of saving even 1 percent of these budgets, i.e., $800 million annually, is worth a gamble of perhaps $50 million. Even more importantly, if such a mechanism shows promise of permitting the education and health services establishments to handle the predicted increased loads at current budgets, then substantial investment in experimentation and later operation is fully warranted.

Other government agencies have articulated their objectives in terms of wishing to learn how they might interrelate with a developing national education network, as this may ease their burden of establishing special-purpose networks involving universities in such areas as bibliographic control of bio-agricultural information.

One representative of a government agency which supports basic research is interested in how networks

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*i.e., the total amount spent annually in the United States for each, education and health. The U. S. Office of Education estimates the 1966-67 total expenditure for higher education at $16.8 billion (approximately $10 billion for public higher education).

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may be designed, and how their performance may be evaluated. Also, since this agency supports the development of computing facilities in educational institutions, there is interest in determining whether these facilities are sufficiently well developed to permit their effective involvement in network activities.

III. A PREVIEW OF NEEDS

The dictionary defines a need as a condition in which there is a deficiency of something. Identification of needs is always difficult and delicate since how can one tell what it is that is deficient—or even that there is a deficiency—unless there is an example of the same condition without the deficiency. People often have intuitive feelings about where needs lie; at least they know the conditions they find frustrating and then search for the deficient element that might ease their frustration. This is how experimental systems come into being. To identify needs, the Summer Study has had to use the intuitive feelings of its participants combined with evaluation of those experimental and operational systems that have attempted to remove presumed deficiencies.

III
Summary
7/7

We shall give particular attention to services which go beyond those that might be available from institutional and individual computers, libraries, and transmission systems, i.e., services which depend on the existence of networks.

Provisionally we characterize a network by:

A. Remote and rapid services regarding selection, acquisition, organization, storage, retrieval, and processing of information and procedures in current files (instructional and research materials, data, computer programs, etc.).

B. Feedback to the:

1. Originator or organizer of the information (hence there would be a community of users improving a common store of materials and procedures).

III
Summary
7/7 Cont.

2. Supervisor of the network services (hence the system would be adaptive to the needs of the users).

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The needs that are to be satisfied by the EDUCOM network are those of many groups. These groups include the student, the teacher, the university researcher, the general community, and industry. The needs that are to be satisfied require the provision of information, documents, tools, services, communication and dialogue, and awareness.

A careful distinction was made during the course of the Summer Study between needs for information and those for documents. Needs for information ranged from that of a physician requiring immediate advice on an antidote for a poison, to a desire for current seismic data, to information in data banks of experimental findings such as sociological information, and finally to information as to who would be the most likely person to supply an answer to a question.

Needs for documents were related to the traditional library activities but were not restricted to these. Thus, not only books and periodicals are identified as documents, but also the other important information carriers such as the report literature, working papers, audio-visual material, and the carrier of machine processable information such as the magnetic tapes that contain the data banks.

Tools included computer programs for processing information. Both the replication of programs for use on the local computer and the long distance use of available programs through the facilities of the EDUCOM network are as meaningful as providing computer-readable information in an available pool.

Services were typified by the central processing of data that otherwise is processed at many places and possibly less completely. An example of this would be a machine-readable catalog of the holdings of all the libraries of participants.

Communication and dialogue need to be aided by data, voice, and image transmission networks.

There was a call for providing awareness of important related work whether it be research or teaching, current clinical record compilation, or the processing of classical data.

XXXIII
Kent
7/29
Cont.

The needs that are to be satisfied must be satisfied more easily than they are now. Thus, some needs require promptness of response; the real time aspects of the computer network are directed toward this need. Some needs require use of all available information; the completeness of resources of the network is directed at this need. Some needs require a constant awareness of new pertinent information; the integration of the network into the inner workings of the individual universities is designed to satisfy such individual needs.

Among the examples of needs that are to be satisfied are:

a. Clinical needs: the diagnostic information and curative information required to maintain a healthy nation.

b. Library service: the generalized and universally-useful processing of documents and other library materials so that pertinent documentary information is more easily identifiable, more readily available, and more quickly obtainable.

c. Political science: the large data banks of demographic information, electoral information, and results of polls make possible a more complete understanding of the political processes of the nation; they also allow a shortening of the feedback loop that has lengthened between the citizens and their government as the nation has grown.

d. Humanities: the analysis and understanding of literary works can be aided both by the "salon" nature of the image transmission network and the ability through computer processing to diminish the drudgery required before certain examinations of text can proceed. Concordances that once took a lifetime are now obtainable in minutes for those texts that are already computer readable.

The needs to be discussed may be approached at many levels and may be organized according to many possible schemata, according to substance areas, functionally according to the user, functionally according to the logic of the information processes involved, etc. No single consistent scheme seemed to be entirely appropriate; the sections which follow represent a hybrid, with main categories corresponding to the university generally, to the library as an institution, and to the health field generally. Most of the overlaps are so obvious that they should not be troublesome.

IV. GENERAL UNIVERSITY NEEDS

The problems associated with increasing student populations seem to have been so generally in mind that few explicit references documented the situation. Some points however were noted:

XXI
Summary
7/22

> Increasing pressures on higher education brought about not only by the absolute increase in population but also the increase in the percentage of 18-21 year olds in higher education. (e.g., 2% in 1850 versus 36% in 1962)

and

XXVIII
Miles
7/27

> While the growth of enrollments in the undergraduate curriculum at the two thousand institutions of higher learning in this country has been extremely rapid, the enrollment growth of the graduate schools has been phenomenal. Hence,the development of the EDUCOM network has something special to say to graduate schools.

That the productive efficiency of the universities has not kept pace with the growth of student numbers was noted.

XXI
Saunders
7/22

> Increased number of students and the increased information generation rate are producing pressures and, hopefully, incentives to increase the efficiency of instruction. While the pressures exist, this paper will attempt to show that the faculty and administration associated with higher education have not risen to the occasion as yet and may, indeed, have regressed further.
>
> A graph of national productivity as measured in gross private domestic product per man-hour would show the semi-logarithmic characteristic of a vital society. A graph of productivity in higher education measured in number of degrees per full-time equivalent faculty member, however, would show that universities reached their peak productivity in 1950 when they turned out two

XXI
Saunders
7/22
Cont.

> degrees for every full-time faculty member. Since then this ratio has steadily declined so that by 1966 the universities will have regressed to the 1880-1920 level in this respect.

In addition to the growing student pressures (for quality as well as quantity), the universities face ever-increasing pressures from government agencies, industry, and the community at large. The concept of public service inherent in the idea of the "land grant" colleges has been considerably enlarged; at this point one may almost refer to "science grant" universities. The State Technical Services Act, intended to support state and interstate programs to distribute scientific findings to industry, will add to the pressure. For example:

VIII
Miles
7/20

> The normal agencies through which the individual state would operate these services under the terms of the bill would be those universities with an accredited School of Business and/or Engineering. Certain types of information and material services mentioned prominently in the wording of S949 or the associated congressional hearings were computer programs, tapes, and technological information about hardware and software advances and capabilities. Other proposed activities fall in the continuing education or extension services realm where the participating faculty contact man would need current selective dissemination of information and current awareness services in the specialized area of interest to his industrial clientele.
>
> The implications of the EDUCOM Network Services for such service activities are immediately obvious. An excellent reference data base, both for support of public service and on-campus commitments would be the tape files of the journal "U. S. Government Research and Development Reports" now being published by the Clearinghouse for Federal Scientific and Technical Information, an agency of the U. S. Department of Commerce.

Other substantial pressures will be exerted by many of the programs of the Department of Health, Education, and Welfare;

some of these programs will be referred to elsewhere in this report.

A set of needs corresponding more specifically to developments in information technology appeared to center around needs for integration, standardization, and coordination. A number of state and regional educational communications systems are in various stages of planning or development and must be taken into consideration; therefore

XXIV
Miles
7/27

> It seems imperative that EDUCOM, through its various committee structures, establish certain technical standards and operation procedures which each state or regional group must meet before they can be interconnected. These standards should apply to digital transmission, telephonic communications, and television, or, in other words, to both narrow and broadband transmission.

and

XXVI
McCormick
7/27

> The observation has correctly been made that the present concept of EDUNET implies that it is a "network of networks." In terms of operating philosophy, EDUNET must coordinate and interlink with other networks. This includes the liaison with existing "interagency agencies" such as regional bibliographical centers and with other regional networks (such as the Office of Education Regional Laboratories).

Other suggestions indicate the need to reconcile input data formats of considerable variety, or they point out the desirability of providing a spokesman for the universities in the American Standards Association, to the communications industry, and to the information processing industry.

In elaborating the role of the professor as an instructor, it was claimed that an appropriate information network will increase both teaching effectiveness and teaching efficiency, as follows:

III
Denum
7/8

1. Increase teaching effectiveness.

The emphasis here is on the nature and quality of performance. In this respect a division of labor, properly utilized, will free the professor from routinely recurrent exercises and allow him to deal with unique problems and creative activities.

Remote and recent materials and ideas will become available on the request of the professor or student, i.e., new or highly appropriate techniques and materials not otherwise available in the professor's present repertoire. In utilizing these materials, the network will provide interaction and feedback between the user and the materials. This will allow inquiry about and modification of the teaching materials.

Participation in a computer-based communications network will stimulate and support a group of subject experts working cooperatively on similar courses taught at different institutions, especially through informal conferences with confrontation arranged electronically at any distance. A current draft of materials in preparation can be in use at all institutions. Concomitantly, this activity will also provide a greater market for the professor's skills.

A network will aid in setting high standards of instruction through the demonstration of other methods of instruction by recognized experts and by providing easy access to current trends and the flow of ideas in the field, i.e., updating the professor without requiring undue travel and absence from his home campus.

2. Increase teaching efficiency.

Selective utilization of support systems will allow the professor to teach more students, both on and off his campus.

Programmed packages of remedial units tailored to the specific needs of his students will free the professor from routine activities, e.g., via a library of programmed units appropriately documented and on-line edited.

The network will provide an increase in relevance and applicability of materials developed cooperatively at a variety of institutions; that is, useful materials will become available to more students more rapidly than through individual ventures.

In considering the information needs of university-based researchers, Merrifield and Mood (III, 7/11) discussed the utility of networks for three varieties of researchers and four levels of confidence in the information. They conclude that the most promising area is in relation to the professional researcher's need for high-confidence information:

III
Mood
Merrifield
7/11

> The professional researcher's need for high-confidence information is immediate. Whether his frontier is in depth or near the periphery of his field, the presuppositions on which his study rests are likely to be based on fairly recent research by himself or others. The need for early confirmation or rejection of these assumed foundations is apparent, if the research program is to be an efficient one. In this regard, immediate dissemination of refereed and edited manuscripts would be very helpful, if indeed not necessary, to the continued acceleration of research. Any early abstracting service coupled with computerized dissemination would be worthwhile.

The participants refer elsewhere to the lag in the publication process attributable to the refereeing and editing processes as being essentially irreducible; it is interesting to speculate whether this is necessarily so, in view of the possibility that editors might have access to well-organized information about the availability for immediate refereeing service of the best qualified individuals. The existence of a network might also reduce the delay associated with routing and rerouting a limited number of manuscript copies through the mails and might also encourage the practice of disseminating prepublication drafts and working papers. Other participants in the study tended to give more emphasis to the possible importance of collaborative efforts through the network; some stressed the need for voice communications (and ultimately full visual communication) to enable immediate, personal exchange of information. In regard to television, the social sciences would appear to have a particular need:

X
R. Miller
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> Of all the various disciplines in the social sciences which could utilize television as a resource or teaching tool, perhaps none requires network capability with more immediacy than do those academic areas which are concerned with current political events and figures and those which deal with the study and evaluation of social movements. Other disciplines would, of course, utilize such a network if one existed but are now often served adequately and economically by delayed transmission via tapes or films which are current and of good quality.
>
> The applications suggested here visualize the use of an educational broadcast satellite placed geographically to supply maximum utilization by educational institutions of the United States. In the beginning it is assumed there would be sufficient numbers of geographically dispersed ground stations which could perform both receiving and transmitting tasks, and which might be tied in directly with regional television networks for effective dissemination to the educational institutions which they serve.

In connection with administrative problems of the universities, reference was made to the need to exchange information about common problems in similar situations:

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Diekhoff
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> Annual meetings of professional associations are the natural setting for such exchanges whether through formal programs, committee deliberations, or the less formal exchanges in lobbies, hallways, and cocktail lounges. But annual meetings have the disadvantages of size, inflexibly planned proceedings, and lack of timeliness. The dean of students faced with his first sit-in, teach-in, or walk-out cannot wait for the annual meeting for advice and cannot easily manage conferences with the two or three of his colleagues who have most recently experienced or are most anxiously anticipating a similar crisis.
>
> A communications network linking comparable institutions could provide not only invaluable information from an administrative data bank—what is the salary differential between professors in the humanities and in

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Cont.

the sciences; what is the age differential—but also invaluable direct communication among responsible officers. Department chairmen in a given discipline could exchange information about their use of teaching fellows to staff undergraduate classes and laboratories; they could conduct joint programs of in-service training and supervision for junior faculty; and arrange for exchange of experience among their junior colleagues. The development officer working on a program to encourage deferred giving or working with a potential donor could consult with his opposite numbers on the particular problem in hand. The director of institutional research asked for information needed by his president for presentation to a board or a legislature could get comparable data (and advice about collecting it) from a sister institution.

Also mentioned were the special needs of mathematics:

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Miles
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The needs of mathematics for service from computerized and audio-visual networks of the type being considered by EDUCOM are manifold. Demands for computer-related instruction for mathematics majors or for students from virtually all fields requiring support courses in computer-related mathematics have grown explosively due to the computer revolution. This has resulted in heavy demands for expanding efforts to train new faculty members in mathematics who are familiar with computer-related methods and their application. A similar demand exists for retraining large numbers of mathematics instructors whose present training includes no background in computers and computational methods.

and of the humanities:

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Shepherd
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Materials in the humanities, at least insofar as they are expressed in natural language, are undoubtedly redundant; and special consideration must be given to providing easy intellectual intercourse between the scholar and the network in the scholar's mode. (The spoken work, for example, carries in its tone, expression, etc., meaning, lost when seen on a page. To study oral interpretations of literary material, the humanist cannot exclude sound.)

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Shepherd
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Cont.

Music without sound would be meaningless. We cannot claim that its analysis, synthesis, modification, or selection without a computer would either be impractical or impossible; we do claim that the computer permits analysis to depths presently unattainable, syntheses in variety presently unattainable, modification in numbers presently unattainable, and selection in combinations presently unattainable.

The potentials for painting have not even been explored. Can the artist use the computer in his creative activity? At the moment this question is unanswerable; hardware can be built and perhaps a new art form, launched.

A second consideration stems from the fact that humanists in the university system generally do not exist in clusters; people with similar interests are more likely to be dispersed than the scientists. If the advantages of cooperative efforts, as demonstrated in the natural sciences, are to be given the same opportunity to exhibit themselves in the humanities, communication, through a network, must be obtainable.

It is to be expected that the availability of the network will improve present research techniques as well as stimulate new procedures in research in a way practically unforeseeable at the present time. New attacks on problems which by present technology are intractable will become amenable to the simultaneous cooperative inquiry of collaborating colleagues.

V. THE CONCEPT OF SHARING

Many of the needs encountered can be conceivably met by appropriate sharing of information resources:

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Taylor
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One of the prime long-term benefits of EDUCOM to the institutional participants is resource sharing. The problem of "haves" and "have nots" is an important one, but the existence of a network may well be the stimulus to small but important resource inputs from the latter group.

Sharing is not a new concept. Libraries have for years had a semiformal system of interlibrary lending, in which the "haves" have helped the "have nots." However, the formalization of EDUNET will tend to open up entirely new areas of resource sharing.

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The information resources of an institutional node in EDUNET can be grouped in six categories.

1. Library-type resources (books, periodicals, reports, etc.). This is the basic formal information resource. It is largely underexploited, probably from habit and the staid image of libraries. Both data-processing requirements and the network idea are forcing and will demand, for self-preservation, a definite move from a passive to a more active role.

2. Laboratory resources. By laboratories, we mean not only the physical space and array of devices, but also the experimental know-how which in different universities will be concentrated in different areas of excellence.

3. Human resources are the most important resources in an institution. The faculty may be viewed as information memories, as information processors, and, most importantly, as teachers. Given the channel capacity, they could play an extremely significant role in the sharing process envisaged here, as lecturers, seminar leaders, or expositors of experiments. A human resource frequently overlooked is the student. Although some may argue the point, the student should be one of the major recipients of benefits derived from EDUNET. In fact, one could say that the network's success may depend on its effect on the educational process, including continuing education.

4. Computing resource sharing is not a new development. However, in most cases, this is thought of only in terms of sharing processing or memory. On-line developments (not necessarily time-sharing) are opening up cooperative and remote use of programs locally developed. The Dartmouth system is an example of this. This form of sharing is particularly valuable for undergraduate and graduate education in engineering, business, mathematics, and psychology. It is not necessary to go through the expensive process of duplicating the development of computer programs in several locations.

5. Data resources. Every active department and laboratory in a university or college develops extensive data in the educational process from research and from doctoral work. Sometimes these data are analyzed and results published, but subsequent use of the raw data is rare. However, continuing bodies of current specific data and massive data collections, such as the census or

From the desk of -
OSCAR REED, JR.

XXVII Taylor 7/27 Cont. meteorological data, are important sources for all fields. Knowledge of their existence, access specifications, and conditions of use are important forms of resource sharing.

6. Local networks. Every academic institution is a member of a number of informal and formal networks: community, industrial, local academic institutions, or larger groupings of institutions by particular departmental or substantive interest. They may be based on any of the preceding five resource types. The important point is that they provide an extension of EDUNET at minimal cost. However, they will require guidelines designed to encourage their development and a set of minimum standards.

To obtain access to these resources, a variety of methods have been developed formally or have grown as informal information nets. In some cases they are substantive systems such as MEDLARS or Chemical Abstracts; in others they are directories of locations such as the Union List of Serials or of information centers such as the National Referral Center. Access systems are just emerging. The network concept offers the opportunity to extend and formalize existing access methods and to encourage the development of new ones.

VI. THE NEEDS OF LIBRARIES

Many of the needs discussed above appear in a different form when viewed from the point of view of the library:

IV Summary 7/7 Two types of library needs were discerned, those of users (students, faculty, and staff) and of librarians.

The first need was defined as that of assuring accessibility to the store of materials and resources from both within and outside of the institution, that is, to get these into the hands of users at the speed wanted, in the form wanted, and in the amount wanted.

The store of library materials was defined as all materials whether acquired by a particular institution or not.

The second need was defined as that of assuring effective and efficient operation of the library.

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Cont.

Need for service was discussed in terms of education and research. Educational needs may be considered from a number of points of view:

1. Professors requiring materials for preparing lectures. Here two to three day service is generally adequate, since the last minute requests often are the result of an instructor's procrastination.

2. Students requiring materials to fulfill assignments and to do independent reading.

3. Employed persons requiring materials when engaging in formal or informal continuing education.

4. Requirement for materials in real time within a classroom, resulting from student questions. Two situations were discussed here:

   a. Known materials being provided,
   b. Unfamiliar materials being provided.

In the former case, the tempo of the class would not be interrupted since no time is needed by the instructor to assimilate the material. In the latter case, too much class time would need to be consumed unless material provided were numerical or visual data.

Research requirements are somewhat different in that problem solutions are often needed, rather than information. Accordingly, it was suggested that problem solutions, properly indexed, be stored along with source materials to be available to the next person with a similar problem.

Very often, real time service is desired when one is in the mood to work, and delays might cause loss of inspiration.

Access was defined in terms of:

1. Determination of existence somewhere (catalogs, indexes, etc.) of source materials of interest;

2. Provision of bibliographic citations of these materials;

3. Identification of location of these materials;

4. Provision of materials *per se*, via:

   a. direct loan from local collection,
   b. interlibrary loan,
   c. copying or transmission of all or segments (nonreturnable).

Access can be attained via search by users or by library staff. Literature searching service should become increasingly available from the library when the user desires to delegate this task.

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Cont.

There was considerable discussion of the differences between access to source materials and to information contained within these materials. The latter can be merely selected excerpts or extracts, or it can consist of precise data.

The need was also discussed for critical evaluations by specialists as now available in various specialized information or data centers. On the other hand, it was considered that it might be useful to have all users of materials feed back their evaluations, which could be analyzed statistically for consideration of the next user, and for establishing priorities in presentation of materials when requested.

The need for dialogue between users and library systems operators was considered important in order to assure precision and relevance of response. The experience with the National Library of Medicine system was cited in this regard.

The needs of small colleges and universities were considered most critical. Their more limited financial resources make it more important that they can tap into the library resources of many institutions even though they may not be able to contribute anything but fees for service. The availability of such service would encourage more outstanding professors to go to small schools, since they would not be academically isolated.

Students and younger faculty will continue to identify needs and demands for new tools and services.

Personnel requirements for the existing libraries as well as for the contemplated services have become critical.

Further analysis of library needs follows:

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A. Relating to User Needs

1. Need for Search for Information versus Search for Documents

We need to make a distinction between the need to be able to search for information and the need to retrieve a particular document. Searching can be accomplished within a body of information with the assistance of the computer working with information not readily expressable in machine readable language, such as pictorial information, recordings, video tapes, etc.

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Users of libraries need documents on occasion; at other times they need information. Documents are needed for study by undergraduates and others, for casual reading, for surveying areas of interest, for research requiring access to original (or exactly reproduced) text, for materials containing graphic information, etc. information answers the need for specific data about concepts, formulae, quantities, location, phenomena, etc., to assist in problem solving. Information lends itself readily to storage, retrieval, indexing, addition and correction via mechanical and electronic means. Documents will probably be always with us because the material in them does not easily or economically lend itself to machine handling. Also, for some purposes (browsing, frequent reference) documents are more easily and more efficiently handled.

2. Current Awareness Service

Current awareness service, by means of annotated acquisitions lists or selective dissemination of information (SDI), now exists in varying degrees in industry, universities, and government. Even where SDI has been offered extensively, users still find accessions lists to be of value. A network ought to offer services of both types of participants. Some individuals may want notification of only highly specialized materials. Others may wish to broaden their interests. The network should make both varieties of notification available under control of the user. Universities, especially, have lagged far behind in providing such services. User needs in such institutions in this respect are probably largely unrecognized.

3. Industry Relation to EDUCOM Library Services

The EDUCOM prototype should also recognize certain information needs of industrial organizations. The symbiotic relationship which has developed between industry and educational institutions is demonstrated by the recent "State Technical Services Act"—which provides federal funds matched by the states to underwrite university support of local industrial information needs. Consequently the relatively large and general collections

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Cont.

of universities are being increasingly used by industry; and in return, specialized industrial libraries could be useful to the academic community.

The general information needs of both organizations are similar, of course; however, industry is apparently expecting faster service than has traditionally been provided for academic research probably because of the profit incentive for providing the service. Another industry requirement appears to be the frequent demand for quite specific subject matter. Conversely, industrial users sometimes desire broad subject surveys of the literature and "state-of-the-art" reviews for which the university could provide an excellent source. Such explicit and immediate application of information to an industrial problem appears different from normal academic requirements and should be considered in EDUCOM prototype development.

Finally, industrial users may often have parochial and proprietary points of view characteristic of their competitive business nature (which presumably would not exist in the university environment). For example, a bibliography prepared for a private firm might need to be disassociated from the original requester—because knowledge of it would show certain product interests that would be commercially valuable to a competitor.

4. Need for Evaluation of Most Advanced Techniques

While the need for improving the operation of our present system of information storage and retrieval, i.e., the library, in terms of taking a next step forward, is undoubtedly of major importance, more advanced concepts must not be neglected. Access to information by utilizing devices and techniques available but untried should be explored. Specifically, select collections of information should be stored electronically and made available through an electronic network to a selected group of workers (i.e., students, professors, researchers). The initial cost of performing this experiment may be high. This experiment should be so constructed as to evaluate the significance of the relative speed of transmission of information into the human mind.

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Cont.

B. Relating to Librarian Needs

1. Acquisition Needs and Library Networks

Several needs for the normal acquisition operations of a library should be noted in network planning. Of course, the most obvious benefit would be the use of the network to avoid unnecessary acquisitions of expensive publications already available in the system. In addition to showing the publications already received, it is desirable to show current items still on order. Such information would be useful to guide the selection and ordering of additional items for any individual collection.

Cost, vendor, and similar purchasing information would be needed by individual libraries in the network and might be easily maintained in the network for budget control and other internal housekeeping tasks. Through a network system of batching orders for new books, lower costs per copy might result.

2. Disposition Needs and Library Networks

A corollary to acquisitions might be the disposition operations of a library. Here again, the network would meet certain needs. The network might show publications being permanently retained at a particular location (as a matter of subject interest or simply mutual agreement). This would allow others in the network to dispose of little-used materials and still have access to a copy if the unexpected need arose. Such an "archival" copy could, of course, be relocated to a relatively low-cost warehouse area for the mutual benefit of those agencies in the network. Statistics on frequency-of-usage might be very helpful in identifying inactive materials, and the network could also fill this need.

3. Serials and Library Networks

Although the needs of serials handling are generally included in the other comments about library operations, particular note should be made of certain aspects concerning them. A number of area union list projects (and the National Union List) have already produced much information for cooperative referencing of these

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publications. This "back-issue" material might easily be improved by more current revision and, more exacting notation of library holdings (to the individual issue level). In local situations, the bound volume information might be helpful in scheduling binding of back issues so that all of the copies are not unavailable at the same time. Here again the network system would be helpful in meeting these needs, and a good corpus of material is probably already available.

4. Retrospective and Current Conversion of Existing Catalog Records

A recognized current need exists to make available catalog data on library collections. The problem may be approached at two levels.

a. Begin immediately to produce the records of current cataloging in machine readable form.
b. Retrospective conversion of the existing catalogs of selected libraries.

There are a few library catalogs now in machine readable form, but these do not add up to significant coverage except in very limited fields. While retrospective conversion is now fairly expensive, current technology is such that ongoing cataloging could be done rather inexpensively. A network would enable a start to be made sooner, if input could go into a central store for manipulation (e.g., Library of Congress program), rather than to establish a system at each institution to process the input. If a start were made with current cataloging, retrospective materials could be added, and even acquired from other users, as funds became available, or as new technology for conversion might reduce costs, e.g., optical scanning.

Once catalog records are in a form capable of computer manipulation, user feedback could be added by use of techniques common to current selective dissemination systems.

A network could be established by interchange of magnetic tape by mail, although electronic interchange would offer obvious advantages.

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5. Interlibrary Loans—Continuing Need For

While rapid transmission of materials over a network may fulfill some user needs, there may be an increased need for interlibrary loans of materials or the provision of photocopy for users who do not wish to pay the costs of electronic transmission. In addition, there are still materials which are not readily convertible to electronic storage and transmission, e.g., 3-D relief maps, rare books, ore samples, etc. The most important aid which a network could provide to fulfill such needs would be, simply, access to information concerning the availability of materials—in effect, a national or international union catalog available through the network.

6. Staffing

A network, which employs modern electronic devices and communication linkages between libraries, and which has as one of its functions the improvement in the management of these libraries to the ultimate benefit of users, will require significant departures from traditional staffing patterns of libraries. In such an environment people with traditional library training who do not adapt by acquiring the requisite skills and attitudes will have limited usefulness. The background which is supplied by traditional library training is of great value, however. A massive effort directed at retraining large numbers of personnel now functioning in libraries will be required to produce the manpower necessary for a real-time network ever to reach a fully operational status. As an appendage to a prototype network, some experimental retraining programs would be well advised.

The recruitment and training of young people to man libraries in the future, when they are linked in the network, is a challenge to the academic community radically to modify the educational experiences now prevalent in most schools of library science. It also is a challenge to the forward-looking educators and practitioners of the art to alter the popular image of the "librarian."

Other discussion related to library needs:

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A. Humanities

Information retrieval (whether of bibliographies, locations of documents, or documents themselves) is as acute a need in the humanities as it is in the sciences. The amount of current information is only less great in the humanities than in the sciences; it is sufficiently large to have become virtually unmanageable by conventional means. The cost of compiling and producing this information is becoming burdensome and present techniques of indexing are relatively primitive. The diversity of sources of bibliographic information, and the incompleteness of each of these forces collation of many sources, placing a burden on the researcher to which he cannot respond. Very importantly, the collation of bibliographic information must be retrospective; current awareness is not sufficient as the obsolescence of older research in the humanities cannot be guaranteed. Thus, with the retrospective dimension, the problem of bibliographic control is very great. It is estimated there are 500,000 to 1,000,000 new items in English and American literature alone since 1900. The lack of sources of support for the humanities makes their plight more poignant, makes them "disadvantaged."

The availability of documents in library poses the same problems as in the sciences. The typical picture: every library which calls itself a research library is (a) competing for rare materials (b) underbudgeted for development of adequate holdings which must include old as well as new materials. The humanities must compete for library allocations with the sciences.

Library indexing is just as primitive in the humanities as in the sciences.

Implications for EDUCOM: whatever the EDUCOM network does to improve the retrieval of information or the availability of documents should include the humanities, which can help themselves less and need help as much, so that on balance they might well merit some priority.

B. Existing Indexes and Library Networks

Much has already been said about the desirability of developing machineable forms of certain major indexes

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that are already available—ordinarily as printed journals (such as Chemical Abstracts, etc.). This note emphasizes that such "full-text" representation of this particular type of journal would be desirable for a library network prototype. Although the most used indexes would normally continue to be available in library collections there are still major indexes that are sometimes needed but too expensive for particular libraries. The network could meet these needs if such journals were available in machineable forms.

C. Translation

A supplementary note seems appropriate related to a particular type of index journal—index to translations (such as Technical Translations). Although there are several agencies attempting to coordinate the available translations, none are up-to-date nor mutually exclusive in coverage. There is also a need for information about "translations-in-process" which is only partially met at present. Finally, this note should underscore the need for foreign language consideration in the network, along with knowledge about translations themselves.

D. Initial System Utilization of Technology Currently Available

The typical academic library now does not utilize currently available technical devices. Further, it has made only modest efforts to explore the possibility of cooperative arrangements to assure better service and better utilization of existing bodies of information. Few academic libraries have realized the importance of offering an active library service to researchers but have, instead, contented themselves with assembling a variety of bodies of data for users. Further, there has been little consideration given to the role of individual research libraries in the whole world of scholarship as contrasted to servicing a particular institution. Every institution has much to give and much to gain from a change in approach.

Cooperation in service to the world of scholars will be made more easy through the EDUCOM system at all its stages of development. It is important that an early

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start be made to impress upon cooperating institutions the importance of utilizing currently available means of information transmission. The telephone has been inadequately utilized between academic libraries. TWX is an inexpensive means of improving on telephone by permitting written records of transactions and location of material. It is quite reasonably priced. Facsimile transmission offers comparatively easy and inexpensive means for transmission of substantive information. Microfilms can be easily mailed from one institution to another. Many of these suggestions seem very elementary (and inexpensive). The point is they are not now being implemented to any degree.

and

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Machine Readable File—Needs

While an EDUCOM network can make a useful contribution to scholarly pursuits by beginning a pilot operation with whatever existing files (in machine readable form) are available as of some starting date (e.g., Jan. 1, 1968), it would seem that a much more important contribution would be made if certain standard library tools were to be put into machine readable form as part of the initial EDUCOM effort.

It seems clear that, in the immediate future, the answers to any questions posed to a network will be in the form of document or journal citations. Such responses will then lead to a question "Where can I find these documents?" If standard tools such as the Union List of Serials, New Serials Titles, and the World List of Scientific Periodicals were available in machine readable form, such questions could be answered readily. More important there would then be a mechanism and an organization to update these files in a timely manner. Now, neither an organization nor a mechanism for timely updating of the above titles exists.

Other important materials for conversion might be the various indexes published by the A. W. Wilson Co.; e.g., Engineering Index.

VII. THE NEEDS OF THE HEALTH SCIENCES

As a field in the university, the health sciences are rather special in nature, in view of the close relations between teaching, research, and health services (through the internship, the residency, and the teaching hospital). Thus, it is to be expected that there will be needs particularly associated with the health service activities, over and above those which would correspond to the normal university patterns of research and instruction. Further, this area of university activity is heavily involved with existing and planned government programs, some of which depend substantially on information services. Needs in the health services area were examined with respect to the potential value of a network:

XII
Kelsey
7/13

1. In hastening broader and deeper application of health related knowledge;
2. In increasing productivity of professional manpower;
3. In improving acceptance and use of existing health care facilities, products, and organizations;
4. In collecting new information for program evaluation and redesign; a better understanding of health and disease.

The special problem of continuing education was introduced as follows:

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Wright
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The proposition to be developed is that as a result of several definable factors, existing inadequacies in information dissemination have contributed to the development of unnecessary and undesirable diversity in professional competency among practitioners of the health sciences. Both "forward" and "backward" influences have contributed to the current state; namely, (1) a rapid expansion in the volume of technical information and (2) inadequate effort in expanding communication capability in the face of this new load. It is felt that parallel advances in the communication sciences have been made, and can be brought to bear on this problem so as to

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> minimize the above disparity through a program of education and information service.
>
> Several negative sociological and psychological factors complicate any broadside attack on the problem especially influencing the possible acceptance of a program by practicing physicians. As a minimum, any program should provide the user with problem oriented information consistent with local practice, conveniently available, and it should be founded on the philosophy of reward rather than punishment.
>
> The development of a data base to serve these needs will require an enormous investment of energy and funds but appears realistically possible. At least as important as developing the data is the development of methods to control, evaluate, and encourage the system-physician relationship. Local conditions affect this relationship and may in fact affect the actual content of the data store in a regional way. Since, however, a significant fraction of the data is not influenced, economic considerations suggest that the program have national as well as regional orientations.
>
> There are currently many independent efforts directed towards the solution of continuing medical education problems. Some appear to be relatively effective; others may even exert negative influence. In either event it is assumed that the utilization of EDUCOM resources to assist in the overall improvement or establishment of programs will not carry the intent of replacing existing operations. There are innumerable areas of interface and overlap in mutual reinforcement of responsibility, function, and efficiency.

Related to continuing education, but not confined to it, is a need for remote conference facilities:

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> One of the prime methods by which a physician enhances his knowledge and skill in the art of diagnosis and treatment is the observation of how an exceptionally skilled clinician practices that art. The method is exemplified by grand rounds, ward rounds, clinical pathology conferences, and similar techniques.
>
> Continuing education should make it possible for the practicing physician to observe, and participate in, such conferences without having physically to remove himself from his community and his practice to the locale of the

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> conference. Appropriate application of modern technology should make it possible for him to observe and participate in such conferences by use of a network terminal at his community hospital, and ultimately at his desk in his office. Audio-video transmission, with audio response, are minimal network capability requirements.
>
> Participation and observation call for a network linking the physician, through a terminal at the community hospital or county medical society, and ultimately his office, with centers of clinical excellence. Presumably, such centers of clinical excellence in most instances would be university medical centers and affiliated hospitals in a metropolitan center. The network should link such a center with a considerable number of communities in which physicians practice. Although reference is made to the practicing physician, there is need for continuing education of other health professionals as well, and it is presumed that universities have a heavy responsibility in this sphere also. The network proposed would be useful in the continuing education of practicing physicians, nurses, technologists, dietitians; in fact, all the paramedical professions. The suggested initial location of community terminals in community hospitals stems both from practical considerations of terminal cost/accessibility, and from an awareness of the multidiscipline teaching for which the network would be used.

Also, continuing education offers an opportunity for a television network:

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Quayle
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> Most doctors are simply unable to return to a teaching institution for continuing education. The time lag between the discovery of new drugs and procedures and publication of same can be drastically reduced by using television. An interconnected network would make it possible for the top specialists in any field to instruct anyone within the reach of a TV receiver. This applies to all fields in the health services. Some work is being done now, but on a far too modest basis.

In health sciences research there may be particularly good reason to arrange for collaborative planning, data collection, and discussion of findings:

VI
Geertsma
7/11

> The application of a communications network might have the most appeal to organizations or agencies with geographically far-reaching programs which could be coordinated through this means. Such programs of agencies provide a stronger motive for collaboration than that provided by investigation zeal alone.
>
> Presently, these collaborations are difficult to arrange and carry on. Investigators who work in the same area often meet both formally and informally at national meetings. In some cases they establish their own national organizations.

A specific requirement for collaboration appears in connection with the preparation of data bases, which may support numerous applications.

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> Common to many projected EDUCOM activities in the medical area is the concept of the generation and maintenance of a subject-oriented data base. The proposition is that there are numerous applications for machine-readable collections of data oriented to a subject base. It is also apparent that in many areas of medical knowledge, the expertise required properly to generate and maintain these bases is substantially resident in the universities of the nation. The proposed resources of EDUCOM (especially those of efficient communication) make possible for the first time efficient collaboration of geographically distant subject specialists in preparing, evaluating, and certifying such data bases. Among other uses, this one appears fundamental to any future proposal for the ultimate development of a national information service covering the field of medical practice and research. It should be pointed out that resources developed for this purpose will have wide-spread application throughout all phases of university activity either directly or as a model.

The relationship between a network and local and regional activities is particularly important in the area of health service, education, and research:

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Geertsma
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> Many of the applications currently most attractive reflect local needs. Health science centers have pressing needs for communication links within their state and

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Geertsma
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Cont.

national areas. These needs are impelling and can command immediate funds for the development of solutions. It seems likely that they will generate patterns of operation, training, and service which will be highly determinative of future large-scale network activities. This is to say that local needs seem to come first, and the responses to these are presently unelaborated, so that interinstitutional networks are likely to be significantly influenced in a fashion not now foreseeable.

It seems clear that coordinating activities of a central nature must be performed through an organization like EDUCOM, in order to take advantage of applications developments made in various substance areas at various places. Although it was suggested in connection with the menu planning application that a network would permit experimentation with and evaluation of the program from remote points, as a preliminary to possible adoption or modification of the program locally, this notion is generally applicable to essentially all computer applications developments, even those whose operation would ultimately be purely local.

A more specific list of needs follows:

I
Summary
7/11

1. Teaching Health Science Personnel: It is felt that teaching by computer would be very valuable in terms of compilation of student information, and for the up-dating of information. Such things as ECG instruction could be programmed on computers so that a student could study and review scientific data fairly easily.

2. Medical Information: It is desirable to have a medical information system of considerable power and range. The inclusion of a great variety of sources is inevitable, and common structure is needed.

3. Clinical Records: With consent of patients concerned, it is desirable to have a central record of clinical information. This would allow not only a retrieval of information on specific cases but also a compilation of statistical information which could be of future use. This is not currently available.

I
Summary
7/11
Cont.

4. Physiological Use of Computers: It appears there is a need for hardware assistance in caring for the critically ill in order to reduce human error and to provide permanent records and displays which the human senses are not trained to assimilate entirely. This would provide for better care of patients as well as production of hard-copy records.

5. Monitoring of Patients: There is a need for the monitoring of patients for intra-hospital use, but also for network use in terms of exchange of information (with other hospitals) on techniques, etc.

6. Collection of Data: EDUCOM should serve as a coordinating and collection center for standard and experimental programs.

An inter-network publication service would demonstrate priority, but would not constitute publication in the formal sense. The NIH information exchange groups could serve as a precedent for this activity.

7. Trained Manpower Skills: An EDUCOM network should provide information which could assist in alleviating shortages of trained manpower on a national basis. It might also keep available up-to-date information on local shortages and suggest why they exist in terms of wages, living conditions, etc.

8. Hospital Information List: Such a list could very well include the availability, on a national basis, of blood serum, human parts, etc. This might require some coordination with the Red Cross as well as Civil Defense but should tend to make such items as specific blood types more quickly available on short notice.

9. Setting of Standards: It was the concensus that any group providing medical information for network use be governed by a set of standards agreed upon by all users which comply with both minimum and maximum requirements. If this is not done, much information might either be too voluminous or not contain all pertinent information.

10. Discharge Summaries: It is suggested that EDUCOM make available for retrieval from a central source patient discharge summaries submitted in a standard form. It is assumed each summary will have to be released for such use by each patient.

Another list, presented for further evaluation of possible applications:

XII
Kelsey
7/13

1. Toxicological information handling
2. Automation of hospital information systems
3. Automation of certain operations in out-patient clinic operations
4. Registry of health care resources
5. Automation of certain laboratory operations
6. National medical case history file
7. National health intelligence system
8. Compacted current information for health practitioners, on demand
9. Ad hoc consultation with consultants
10. National medical information system (e.g., Hemotological information)

Special attention was given to the need for better dissemination of toxicological information via computer, and if necessary, by satellite transmission as supported by the report, "Handling of Toxicological Information," of the President's Science Advisory Committee. For example:

I
Summary
7/7

A patient arrives at a doctor's office with the information that some foreign substance has been ingested. The problem is to identify the material ingested, to get a report on that material, to determine the antidote, etc. What are the effects and side effects?

Presently, such information must come from a Poison Control Center where information is often either not available or slow in response. Oftentimes in hospitals, one member of the staff is given the responsibility for poison information even though he may not be trained as a toxicologist. It has been said that less than 50% of poison cases are reported because of inadequate assistance from Poison Control Centers.

and

XII
Wright
7/13

In 1965, 85,000 cases of ingestion of toxic substances were reported to the National Clearinghouse of Poison Control Centers. Estimates of unreported cases range from one-half million to two million. Nearly seventy-five percent of the reported cases involved children

XII
Wright
7/13
Cont.

> under the age of five. While over fifteen-hundred different toxic agents were reported, the majority of these agents were common household materials. The number of reported cases in 1958 was only twelve thousand, suggesting both an increase in reporting percentage, and also an absolute increase in cases.
>
> In almost every instance of poisoning, immediate and appropriate therapy will prevent a fatality or significantly reduce morbidity and disability. As a result of the great variety of toxic agents involved, appropriate therapy involves the consideration of complex factors. Decisions involved in this therapy must be based on reliable information which is immediately available. Relatively few practicing physicians are exposed to the problems involved with sufficient frequenty to maintain proficiency in this area. Generally, the public is even more poorly prepared to deal with these critical situations even though the layman usually has the first opportunity to institute therapy at least at the level of first-aid.

Other specific needs discussed include identified program objectives of the Division of Hospital and Medical Facilities, U.S.P.H.S., in respect to community planning; design, construction, and equipping of health facilities; organization and administration; and services. Related is a need in connection with community health care systems:

XI
Conrath
Shipton
7/13

> There presently exists a lack of effective communication between those community agencies which have responsibilities for health services (community hospitals, nursing homes, psychiatric and other clinics, and public health departments are examples) and such socially concerned organizations as welfare, rehabilitative, reformative, and counseling agencies. In large measure this lack stems from the increasing complexity and narrow specialization which is characteristic of modern health care. However caused, the isolation has produced attitudes of misunderstanding which have led to exceedingly inefficient use of existing health care facilities.

Also related to this set of needs was the expressed need for a "Health Service Skill Book":

XI
Bartscht
7/15

A national network which would maintain an inventory of job openings by skill, graduates, etc., seems to be an absolute necessity for planning educational facilities. The importance of such a network stems from the disproportionate availability of educational facilities in the individual states.

4

Applications

I. CHAPTER SUMMARY

The preceding chapter outlined the need for a network facility. In this chapter we deal more fully with those information systems that could be established via a network; that is, the uses of a communications network. The distinction between these chapters is largely a matter of orientation. Thus, the present chapter discusses in detail network applications which relate to the earlier discussion of general areas in which a network facility is needed.

The chapter is divided into five parts (after the present section). One part is devoted to the problem of organizing the vast variety of possible uses for an effective presentation. A number of organizations which were proposed during the Summer Study have been considered and rejected as not meeting the two criteria used: schedulability and interactivity. These criteria seem to be independent of discipline, mission, the availability of materials, the academic function, and the confidential nature of the materials. This independence is considered to be an advantage to the effective presentation of the potential applications of a communications network for education.

Succeeding parts are devoted to the classifications of noninteractive scheduled, noninteractive nonscheduled, interactive nonscheduled, and interactive scheduled applications. We discovered that it is not easy, in discussing individual applications, to limit the discussion to these classifications. As a corollary, we find that desirable applications in several of these classifications span essentially all of the disciplines and missions and are, in effect, universal.

This chapter cannot hope to present all of the possible applications of a network; it is limited to those that were discussed in the records of the Summer Study and depends heavily on quotations from those discussions.

Each section ends with a table which shows an expected implementation date for the applications discussed in that section. We should caution that these implementation dates are independent of each other. That is, applications identified as being scheduled for 1968 could be accomplished in that year if no other applications would have to be simultaneously scheduled. If the funds or people required to conduct these programs were limited, only selected applications of those scheduled for 1968 could be accomplished in that year.

II. ORGANIZATION OF APPLICATIONS

The EDUCOM Summer Study developed an extensive list of suggested applications. At least 46 of the working papers prepared at the study deal directly with at least one application; more frequently a working paper considered a dozen applications. Indeed, the valedictorian felt it worth noting that only the fields of theology, entertainment, and black magic had been neglected.

A partial list of potential applications for a proposed network follows:

1. Directories to bibliographic materials
2. Retrieval of bibliographic materials
3. Current awareness services and automatic dissemination services
4. General availability of computer assisted instruction (CAI)
5. Poison control network
6. Other diagnostic and curative information networks
7. Directories to existing data banks and computer programs
8. Exchange of computer programs
9. Availability of computers per se to remote locations and to "computer-poor" groups
10. Access to existing data banks
11. Acquisition of data from geographically dispersed sources
12. Sharing of experimental facilities
13. Directories of on-going research, theses, proposals, grants, and contracts
14. Directories of people with special knowledge and skills
15. Access to knowledgeable people for "on-line consulting"
16. Holding of live classes, seminars, conferences, professional meetings, etc., at dispersed locations
17. Continuing education
18. Facilitation of joint authorship and "on-line reviewing."

With such a range of possibilities, it became clear that some way was needed to classify applications. A number of attempts at classification were made. Schemes were proposed to classify by the discipline to be benefitted, by national mission to be served, by the machine-readable availability of the data (or programs), by the security classification of the data, by the academic function (instruction, research, administration) to be served, by the network configuration required, by the transmission characteristics needed, and by the function served. It became apparent that every potential application has a large variety of characteristics that could be used in such classification schemes. Which is to be preferred depends mainly on who is to use the classification scheme. Thus, the engineer responsible for designing a network will be interested in the groupings by transmission characteristics and network configuration; the executive, mindful of the need to reach operational status, will be interested in the availability of data banks and the national missions to be served; the faculty member may be interested in a classification by discipline or, perhaps, by academic function.

It appears necessary to speculate somewhat on what the main contributions of a network might be so that we can identify characteristics that are distinctive to the EDUCOM concept and thus useful for characterizing applications of EDUNET.

III
Mood
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The opportunity for interaction. An essential feature of a network is the opportunity for interaction between the sender and receiver—an opportunity not found in films or TV transmissions. Some users of the network will take advantage of this feature. Thus, a professor of surgery may ask his class to observe on TV a surgical operation taking place on another campus and may from time to time ask the operating surgeons or their aides

III
Mood
7/11
Cont.

to show his class certain aspects of the operation that might not otherwise have been televised.

On other occasions the network may be used in a way that makes little or no use of the feedback feature. On such occasions the network may nevertheless deserve substantial credit because it provided a convenient channel of communication. Thus, the professor of surgery could, in theory, have found a film almost as suitable as the live operation, but it is a nuisance to search film catalogues and to order a film; further, he should really view the film in advance to determine whether it shows the aspects of the operation in which he is particularly interested; then there is the possibility that the film contains other material in which he is not at all interested, or it may be an old film with out-of-date material. Thus, the mere convenience of the network, aside from its feedback feature, may make a large contribution to teaching and research.

If a document is transmitted from one campus to another over an electronic network instead of by mail, the network has merely carried out an old activity somewhat more quickly (and more expensively), assuming that the person would, in any case, have requested it by the slower method had the faster not been available. The network would make a very small contribution in this instance because teaching and research are not high speed operations.

If, on the other hand, the user would not have requested the document by the slower method for whatever reason, then the network has made a significant contribution.

A much larger contribution is made when the network enables an activity to take place that would be out of the question without it. For example, a professor on another campus might be asked to observe on the TV screen an animal that is behaving curiously after some training or treatment on which the professor is an expert. This activity would require only a few minutes of the professor's time, thanks to the network. One would not have considered asking the professor to travel to the campus, taking the animal to the professor, or going to the trouble to make a film of the animal's behavior and asking the professor to view and comment on the film.

It is now difficult for, let us say, two mathematicians on different campuses to collaborate because their ideas

III
Mood
7/11
Cont.

> (usually in the form of their mathematical equations) must be written down and mailed back and forth. The value of collaboration is mainly in the spontaneous generation of ideas stimulated by the sympathetic presence and comments of the other person. The mail cannot possibly generate this kind of rapport, and the telephone cannot do it either, because symbols, experimental configurations, and equipment that the eye can grasp in a moment must be laboriously described in words—thus generating impatience and boredom instead of spontaneity. A TV channel would solve this problem very nicely.
>
> We may therefore expect that the presence of a network may stimulate a great deal of collaborative research between persons on different campuses. This effect should generally improve both the quality and quantity of research. It should improve the quality, because two persons who choose to collaborate will usually have a positive interaction with each other and one will often correct the errors and weaknesses of the other. It will improve the quantity through the mutual stimulation and additional enthusiasm generated by collaborative research.

Resource sharing. Taylor discussed the concept of sharing of resources at some length (see pages 59 - 61). He pointed out that the resources a communications network can make available for sharing include library-type resources, laboratory resources, human resources, computing resources, data resources, and the resources of local networks. Mood also pointed out that:

III
Mood
7/11

> The network will allow a research worker on one campus to use equipment or a facility on another campus in his research. Usually this kind of activity will take the form of a collaboration with a person who has ready access to and familiarity with the facility on the campus housing it. But some facilities (for example, a computer) can be used very conveniently over a network channel without any need for a collaborator, and this use of the network will grow as technology advances.

From this discussion we see that among the distinctive characteristics of EDUNET are the opportunity to share resources and the opportunity to have the parties connected by EDUNET interact. Whenever we want to share a resource the question immediately arises as to whether the sharing need be scheduled. Thus, we are led to characterize EDUNET applications along the lines of "schedulability" and "interactivity." In using these terms for classification purposes we realize that we can only look at a small portion of the total "space" of application classification. We also realize that certain kinds of applications may at some times be schedulable and in other circumstances nonschedulable—or may some times make use of a high degree of interaction and at other times require little or no interaction. Nevertheless, let us examine applications in this fashion.

The accompanying figure (Figure 4-1) is a picture of a way certain applications can be arranged in the schedulability—interactivity frame of reference. We realize that, for most applications, a range should actually be shown in such a diagram depending on the particular circumstances and use. For example, a large volume of references to medical literature can be scheduled and is scheduled currently. On the other hand, access to toxicological information is often needed rapidly, while the person requesting the information is still on the line. Such access can certainly not be "batched" or scheduled.

The importance of this figure does not lie in the precise positioning of the various applications but in showing that the range of applications of a communications network includes such seemingly disparate areas as broadcast educational television, interactive television seminars, computer-based directories and information retrieval systems, and community health care networks.

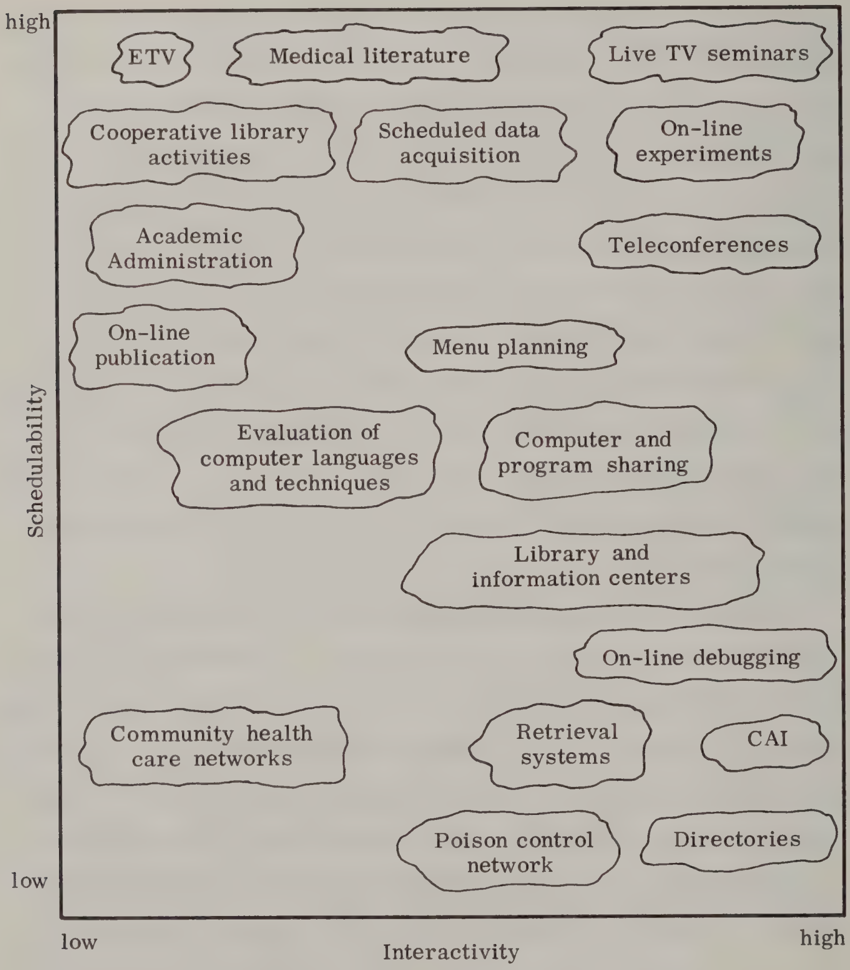

Figure 4-1. Schematic of several applications categorized by schedulability and interactivity.

III. NONINTERACTIVE SCHEDULED APPLICATIONS

In this section we will discuss applications of EDUNET which permit prior scheduling and which (at least in the form considered) do not require a high degree of interaction between the parties involved. That is, communications that could be served by the mail or some other existing form.

Educational television. The purpose and value of educational television is widely recognized. We therefore will discuss only certain uses that would be significantly facilitated by a national network. We will return again to education television as an application under those uses which are interactive and scheduled.

X
R. Miller
7/18

> These capabilities (national educational television, perhaps by satellite) would make available many live program possibilities. These would include the presentation of world-renowned figures, speakers from any point in the United States, special sessions of Congress and the United Nations, debates and other forms of educational competition between universities, and various kinds of direct interchange between universities or a consortium of universities. For example, if the University of Iowa had secured a speaker of unusual interest on foreign policy, the event could be made available to many other universities live. With the addition of a voice circuit the speaker could perhaps answer questions generated on other campuses.
>
> Another area of interest to most universities and one which is growing in importance because of the United States' role of world-leadership, is that of international education. Many universities are becoming involved in some form of international education either through direct ties with overseas areas because of specific departmental interests and capabilities, or because of federal grants and contracts or funds made available for this purpose by any one of several foundations.
>
> To mention only two such international projects, there is the Michigan State Center in Nigeria and the increasing interest in the link between the University of Washington Health Science area and the Far East and Southeast Asia. Within a reasonable period of time it would seem that a system of satellite communication could provide a superior method of two-way communication between projects in the field and the home university.
>
> Some professionally qualified organization would have to undertake the vital role of central scheduler and coordinator. It is suggested that EDUCOM could very well provide this major management responsibility as the direct representative of a large segment of American

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Cont.

universities. The role of EDUCOM may be "viewed as a capital gathering, disbursing, and coordinating organization, not a centralized production unit,"[1] an agency through which federal funds are sought to establish such an educational television system, and when that has been accomplished, to act as the administrator of the property, to schedule its use, and to provide for its operation.

There seems little doubt that a network to carry educational TV nationwide is a possible first step toward a centralized EDUCOM network service since it can utilize known hardware, skills, and capabilities.

XI
Quayle
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Television appears to hold substantial potential for use in schools of medicine. A few uses in this area are listed below.

1. In many instances all kinds of demonstrations which are difficult to show to groups of students can be made more vivid and larger for better viewing by using TV. Operating procedures are the best example.
2. A network could allow for the sharing of faculty resources by "transporting" an outstanding teacher electronically to numerous classrooms at any number of institutions.
3. Grand rounds from any number of hospitals could be viewed by students at all participating institutions.
4. Clinical pathological conferences could be shown to various groups. Color for this increases the cost somewhat.

Uses that could be made of a national television network are too numerous to describe in any exhaustive way. At this point we will simply list the following:

1. Consultative diagnoses would be possible with a feedback type of network. Transmission of X-ray motion pictures and other data to "consultants" in different

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[1] Quoted from an article by Vincent P. Rock, Director of Communication Central, a Washington organization dedicated to the global uses of technology, and a consultant at Georgetown University. This article appeared in the May 1966 issue of EDUCOM, Volume 1, Number 5, and was titled, "Universal Education by Satellite."

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Quayle
7/18
Cont.

> locations will some day make it possible for several specialists to "examine" a patient from a distance using television.
>
> 2. Cameras located in the emergency area of a hospital will enable students to observe a patient in the very initial stages of the case. It is said this could be highly instructive.
>
> 3. Students, interns, student nurses, anesthetists, pharmacists, etc., could be monitored or observed by faculty for purposes of criticism and instruction.
>
> 4. Medical conferences could be televised, making it possible for anyone anywhere in the country to "attend" with very little time or expense involved.

There appears to be no technical reason why a national educational television network to serve such uses as have been described could not be established at once. Already there are numerous regional networks which could be interconnected with conventional equipment. This would be a natural first step toward the development of an interactive television network, perhaps using satellite communications.

Library use of a network. In this section we will limit our attention to library applications which can be scheduled and which do not require a substantial interaction over a network. There are many library applications which do not satisfy these restrictions. They are discussed in subsequent sections.

IV
Mersel
7/14

> The items that will be discussed have to do with mechanization of the inner library activities. That is, they are intended to make life more convenient, or less expensive, or more effective in the operation of the library. They are aimed primarily at the librarian rather than the user. It is assumed that those users who currently find the library effective enough to patronize will find the library even more effective after the inclusion of the prescribed services.
>
> 1. The first item is the creation of a machine-readable union catalogue of new acquisitions. This union catalogue

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Mersel
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Cont.

would represent the holdings of the libraries in the EDUCOM community. It would start with holdings that are acquired after some convenient date, perhaps upon the entry of a new university into EDUCOM. Such a catalogue would be capable of being queried through consoles located at the distant libraries. (Such inquiries could be scheduled.) If convenience dictated, the catalogue could periodically be placed in hard copy form. The first need in developing such a catalogue is the creation of uniform standards for listing each new acquisition and determining how it is to be recorded. Thus, in this as in other items, we immediately face the need for establishment of standards.

2. A second item is the union catalogue of serials acquired by each library in the community. Here, as the periodicals grow older, there is a temptation to eliminate them from storage because of space considerations. Individual members of the community can take the responsibility for preserving particular serials so that multiple collections are no longer needed for old materials to give assurance that a particular serial can be obtained.

3. The input of the titles of the articles in the individual periodicals, that is, information taken, not from the table of contents, but from the title page of each article (the title of the article, the author, the professional organization, etc.) could be the basis for a valuable service. Work done by Kessler at M.I.T. on physics journals indicates reasonable retrieval is achieved by manipulation of these data for these otherwise unindexed materials.

4. There could be an open auction on acquisitions, resulting in conservation of acquisition money so that a larger total collection can be obtained with the same funds. Thus, if, through the network, various libraries could decide simultaneously whether they wanted to acquire particular items for their collections, some libraries could reject marginal items if they received the assurance that these items were desirable for another library within the community. In addition to updating the union catalogue of acquisitions, there might be some use in keeping a separate catalogue of items that were not purchased by anybody within the system.

IV
Mersel
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Cont.

5. Interlibrary loans are already a part of the library system. It is expected that interlibrary loans will be an even more natural part of the network. Records can be maintained on the borrowing of items within the community. A balance of payments procedure can be instituted. Thus, each library might decide ahead of time how much it would be willing to pay for the privilege of borrowing. At any time, it could check to see whether it owed or was owed money. It could also be alerted ahead of time if it was in danger of owing more money than it had initially been willing to commit.

6. The utility of the interlibrary loan is based on having ready access to the individual books. Thus, part of the accessing system should indicate whether a book listed in the catalogue is currently on the shelf or is unavailable for some reason. If the book is not immediately available, the requesting library can decide whether or not to acquire the item from another source.

7. Standards are needed for a retrieval program. The assumption that has been made so far is that there will be a union catalogue of holdings. In addition, the Library of Congress has already started to put its new holdings on magnetic tape. It may well be that the standards adopted by the EDUCOM library group could conform to the standards adopted by the Library of Congress. In such a case, new entries to the union catalogue would be analogous to buying catalogue cards from the Library of Congress. However, whether standards are identical or different, the computer program for retrieval should be capable of identifying any acquisition of the Library of Congress as well as acquisitions within the EDUCOM Community. The retrieval programs should also be capable of using the information contained in other machine readable indexes.

8. Having been able to identify the reference through the retrieval program, procedures must be established for the transmission of individual holdings not only through the mail (as is now done) but also by electronic facsimile (such as long distance xerography) when the receiving library is willing to pay the cost.

9. Records on borrowing are easy to gather within the system described. Attention should be paid to the need to determine what records are to be kept so that programs can be written with this in mind.

IV
Mersel
7/14
Cont.

10. Statistics on borrowing are a natural result of the record keeping; they are, indeed, one of the main purposes of the record keeping. From these statistics a library can begin to obtain some indication of the desirability of the individual items in its collection. These inferences might be drawn from frequency of withdrawal, length of time of withdrawal, or requests from other establishments. Future acquisition and disposal policy would have a firmer basis for its formulation.

11. As distinct from statistics on borrowing which are oriented around the items borrowed, statistics should be kept on which individuals have borrowed what items. This makes it possible to know which part of the community is receiving effective enough library service so that it is willing to continue to use the library. This can be important as a basis either for providing better service to those using the library or for finding out what is needed to be able to provide service to those not using it. Such statistics should be used for maintaining a selective dissemination profile. Thus, when an individual borrows books with certain subject characteristics, he should be informed of new acquisitions that have similar interest profiles. Indeed, the record of borrowing by individuals would allow one to keep dynamic profiles rather than the more static profiles common in selective dissemination of information systems.

12. The statistics on the borrowing of individuals also can be used to create a capabilities directory. Thus, when particular knowledge is sought, one can turn to the borrowing statistics to determine who is likely to be expert in the combination of subjects required.

A concensus formed during the EDUCOM Summer Study was that libraries can be significantly served from the very beginning by even the most primitive network suggested. However, to assure that benefits will be realized from the beginning, immediate planning and setting of standards are essential.

Medical literature. MEDLARS is a document referencing system for medical literature which has been operated for

From the desk of -
OSCAR REED, JR.

about two years in a scheduled, noninteractive manner. Substantial experience has been accumulated, although MEDLARS does not yet have the advantage of being available through a network.

XVI
Mittleman
7/29

MEDLARS contains some 420,000 citations for the period January 1964 to July 1966; 45,000 more citations provide fragmentary coverage for 1963. The minimum number of characters in a citation is 166; but, more typically, a citation has 250 to 300 characters. Thus the citations currently consist of approximately 150 million characters, well within the capacity of available storage files. In fact, with trillion bit files recently announced, 1250 years of MEDLARS could be retained in numerically coded form. Presently about 10,000 descriptors are in use and this number is growing slowly.

The current procedure at the Denver center is to run one batch of searches a week. Therefore, a requester gets one-day service only if he submits his search request just in time for it to be prepared and processed in the weekly run. Interviews now average an hour to an hour and a half, and the searches suffer from lack of dialogue between the requesters and the search specialist. Thus far, there have been no complaints about the seven to ten day response time because of the improvement over conventional library searches which can require months or never be completed.

Among the difficulties encountered by MEDLARS, which might be at least partially alleviated by its being on a network which has many other uses, are:

1. The difficulty of making effective use of on-line time which could be shared if there were other network applications.

2. The cost of constructing programs to introduce the uninitiated user to the system. Since the same (or very similar) programs would be needed for the uninitiated users of other data banks in the network, these costs would be spread over a wider base.

3. The high cost of immediate response. A nationwide network would be able to schedule searches more frequently; and yet, because the network is shared with other applications, the cost would not be prohibitive.

XVI
Mittleman
7/20 Cont.

The Summer Study considered MEDLARS to be a prime candidate for inclusion as a data bank in a national network.

Scheduled data acquisition. In many cases data can be acquired through a network on a scheduled basis as when an accelerator is operated at a scheduled time, or meteorological measurements are made by automatic stations on a schedule, or stream flow and pollution measurements are taken on schedule. Seismic data (discussed later as unscheduled data acquisition) can be recorded at the sensing station and periodically transmitted over the network to processing stations. There seems no end to the variety of data that might profitably be collected through a network whether the data pertain to solar flares, to oceanographic measurements, or to analysis of pesticide runoff in streams. This is a field in which we are certain the availability of a network will generate more specific applications than we can now list or imagine.

Other schedulable applications. Many of the applications discussed later as nonscheduled could be operated in a less effective way on a scheduled basis.

For the present we will limit ourselves to noting a few uses in academic administration for which a network could have value.

To make the maximum use of facilities available in a college it would often be very useful to know of and have access to facilities in other colleges. A communications network could be used to locate and use specialized equipment for research and instruction located elsewhere, to compare the performance of such equipment, and to assist in determining the need for equipment acquisition in much the same way that library acquisitions could be made on a cooperative basis. A network could be used to record and relate the progress of students in different institutions and to transmit and make more meaningful the transcript of the student's work. In following this line of thought, a communications network could be useful in processing applications for admission, since students generally apply to several colleges. It is possible that the expense and uncertainty associated with the admissions procedure could be sharply reduced. The Summer Study did not conclude that undergraduate admissions processing by means of a network would be desirable. However, it was thought that such communications could be both appropriate and useful for medical and nursing students.

XI
Geertsma
7/14

> Medical students would apply with one application, stating their rank-order preferences for schools in the system, and choosing as few or many schools as they wish. They would be interviewed at each school, or possibly each of N schools could interview 1/N of the students, and the interview impressions shared by all. Scores would also be supplied for each student on selected admissions tests and variables. Each school would make a decision of admit or not-admit about each student. The matching of students to schools would then be performed by computer to fill each school's entering class. The computer program would have to be written so as to make some inclusions and exclusions on bases other than the admit or not-admit label. This could be done by subdividing the admit designation into priorities, or perhaps by working for a maximizing of certain admissions data scores or other factors depending on each school's preferences. This system would eliminate multiple acceptances of a student and would assure that the acceptance he does receive would, as much as possible, agree with his stated preference. Certain students might be marked admit by the schools but not accepted because of a lack of places for them. Such students would be easily identified and might be referred to other schools outside

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Geertsma
7/14
Cont.

the system or otherwise counseled regarding their health science careers.

Nursing admissions could also be handled as above, probably to even greater advantage because nursing programs are less standardized than medical curricula.

Table 4-1. Possibility of Implementing Schedulable, Noninteractive Uses

Application	Implementation	Remarks
Educational Television	1967	Regional networks can be interconnected.
Inner Library Activities	1967	Agreements on detailed formats and standards are needed first.
Medical Literature	1967	Invaluable experience from MEDLARS.
Scheduled Data Acquisition	1967	Impetus for specific applications is likely to come from individual users.
Academic Administration	1967	Will require negotiations and agreements among universities exchanging such information.

IV. NONINTERACTIVE, NONSCHEDULED APPLICATIONS

Here we will discuss applications for which the communications activity takes place when the need arises, that is, on a nonscheduled basis. We will continue to limit ourselves to those uses which need not have an immediate response over the network.

Data acquisition. Experimental data frequently become available at unscheduled times. Their collection and processing may not require interactivity between the data source and processor. For example:

V
Kochen
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Psychologists may wish to collect responses of subjects (low data rates) in reaction time experiments for storage on magnetic tape. Psychiatric researchers may wish to have observations about patients recorded by nurses on magnetic disks, tapes, or even punched cards anywhere and anytime (very low data rates). Chemists may wish to record digitized readings of a spectrophotometer, and neurophysiologists or seismologists may wish to record digitized time functions (high data rates).

There are basically two reasons that such recordings of data should be network applications. First, as in the case of seismological data, the measuring instruments may be geographically dispersed. Second, the cost of providing recording equipment to accept data at the rate needed to even a moderate fraction of the investigators desirous of acquiring the data could become prohibitive, especially for smaller institutions.

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If total data rates are such that transmission over voice-grade lines is adequate, sharing (without undue loss of priority) the tape-recording facilities of a larger university (or of a network laboratory) in the EDUCOM network could provide data acquisition capability to researchers wherever located.

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Simply as an example of a data acquisition network, consider the problem in seismology. Earthquakes and nuclear explosions occur at unpredicted times and with varying intensity. There is in existence a seismic detection system (The Montana Array) linking 525 seismic detectors together covering an area of 30,000 square miles. Large quantities of data (e.g., a reel of magnetic tape every ten minutes) are recorded and transmitted to a central facility for processing.

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Severe disturbances have consequences of interest to geophysicists, geologists, and engineers. They would like to be alerted to disturbances of a given magnitude as indicated by seismic instruments. Once the disturbances have been called to the attention of the investigator, he may wish to see the readings of a group of

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instruments located around the nation and at more remote locations. The group of investigators at scattered locations on the network could benefit from a conference-call type of discussion, with visual display of seismic instrument charts. The group no doubt could agree on an interpretation of the readings in terms of the initiating disturbance.

Today, the scientist in charge of the seismic instrument reports his interpretation of the readings through the press, without the benefit of collaboration. Workers who do not have access to seismic readings forego the experience of on-the-spot interpretations.

A seismic interpretation group could be organized in EDUCOM. This group could arrange for connecting a series of geographically remote seismic instruments into the network. At a previously agreed upon magnitude of disturbance, the instruments can initiate an alerting message to the seismic interpretation group.

The communication system can permit individual investigators, once alerted, to request and receive instrument data from various locations. When a disturbance occurs which appears to merit discussion, the individual investigator can initiate a conference discussion of the disturbance for interpretation.

The benefits in having group evaluation of seismic disturbances can be listed in three categories: (1) The public is entitled to know the best opinion concerning events as soon as possible; (2) the government will have the best and quickest information relative to safety or defense measures to be taken; and (3) the educational level in this discipline will be up-graded because of the experience of on-the-spot interpretations.

It is estimated that a year's time would be needed to organize a seismic interpretation group, agree on the instruments to be tied to the network, and to establish the communication lines.

Evaluation of computer languages and techniques.

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At the present time, the understanding of computer programming languages and advanced methods of processing data is not uniformly distributed. Even with the wide use of more sophisticated computer languages, significant programs, such as a compiler for a new language,

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are prepared to operate on the particular computer available to the developer. As a result, individuals and groups throughout the country design programs to carry out the same (or nearly the same) function. To cite an example, it might take years without a network, but only months with it, to determine the relative merits of SNOBOL, COMIT, LISP, FAP, and ALGOL in handling a particular approach to the syntactic analysis of English. With the network, the investigator with the problem could make remote use of the several programs, each on the computer for which it was designed.

There would be many more exotic possibilities of program interchange and on-line program testing if the network permitted a highly interactive mode of operation. Yet, even without high interactivity, a network would facilitate the distribution of knowledge of language and techniques. It would be convenient, for example, to compare the effectiveness of several local groups, or several languages or techniques, in comparative tests. It would be possible for an advocate of a novel method to prove it to his skeptical colleagues or to disprove it to himself, even though his colleagues may be geographically remote—as they usually are, since few institutions support several experts in the same field. It is expected that establishment of a communications network could immediately make programs and computers located at a distance more accessible and result in improvements in the awareness and evaluation of such facilities by investigators in all disciplines.

Community health care systems. The lack of effective communication among community agencies responsible for health, welfare, rehabilitation, and other services has been noted earlier.

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The use of a simple low-data-rate wire service network with easy and rapid access is a means to reduce these difficulties. There are at least as many interdependent community agencies as there are university departments, and their need for communication is certainly as great. In many health care communication situations, time is of importance; currently much of the data accumulated by state and local agencies is neither complete enough nor timely enough to serve as a reliable

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basis for action. As an example, we cite the difficulty often experienced by a physician in locating special nursing home services. It is becoming increasingly necessary to search for such facilities outside the immediate local community, and a statewide service represents an absolute minimum.

In addition to serving a communication function, the system would also accumulate data for the guidance of those responsible for planning continuing education by establishing patterns of need.

It is understood that from a pedantic technical viewpoint facilities (e.g., the telephone and telegraph) already exist to serve these needs. However, it may be that novel means of access and data presentation will be required to overcome the inertia and apathy which several decades of dependence on existing media have produced.

The proposed network would be an adjunct to existing functions in the sense that it would in no way substitute for casework. This criterion will also ensure that confidentiality of records and the rights of privacy will be preserved.

Table 4-2. Possibility of Implementing Nonschedulable, Noninteractive Uses

Application	Implementation	Remarks
Data acquisition (seismic)	1968	Impetus for applications may come from professional societies and other groups but can be coordinated by EDUCOM.
Evaluation of computer languages and techniques	1967	More interactive exchange and evaluation would start later.
Community health care systems	1967	First efforts may be on a regional basis with expansion possible geographically and toward an interactive network.

V. INTERACTIVE, NONSCHEDULED APPLICATIONS

When a higher degree of interactivity is possible in the network, a flood of possible applications emerges. All of the possibilities discussed so far take on a new dimension and a multitude of other specific applications suggest themselves.

Data bases. We will make some preliminary remarks concerning data bases since a large number of applications envisioned for an interactive network amount to access to and search through a well defined collection of data, i.e., a data base.

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Data bases are especially important at the present time because current technology is making access to such collections of data ripe for exploitation. It may also be said that the development of our culture is in a phase in which arrays and collections of quantitative information are particularly significant. In any event, many of the things EDUCOM should do—many of the activities that EDUNET can facilitate—involve data bases. Moreover, it is in the area of data bases that some of the more significant interactions between the universities and federal government can take place, and it is EDUCOM's purpose to foster and facilitate such interactions.

One set of data base projects is the development of registers, directories, and indexes. Many such projects can be called "experiments." Therefore, data base projects, like experiments, should be conducted in such a way as to provide for evaluation. Sensitive evaluations of data base projects will be difficult to achieve; nevertheless, intensive effort should be devoted to evaluation.

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The problem of data resources in EDUCOM network reduces, in the first phase, to a directory system with the following characteristics:

1. There is on-line access to the directory in a conversational mode;
2. The directory contains descriptions of the data collections available;
3. The directory contains instructions on how to locate and access each data collection;

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4. The directory indicates the condition of the collection, its currency, and some type of evaluative statement;
5. The directory indicates any conditions of use and access (e.g., charges).

The primary concerns during this initial phase should be with:

1. Establishing storage formats for the directory information;
2. Providing for intellectual access to the directory (in the beginning, this may be by using a trained person to search the machine stored directory);
3. Establishing standards for accepting data bank information into the directory;
4. Acquiring the directory information itself;
5. Encouraging the development of machine-readable files for items already in the directory;
6. Encouraging the development of new files where particular gaps are noted;
7. Developing cooperative agreements with other data bank directories; e.g., the National Referral Center.

The intent of this directory is to provide centralized descriptive and access information about small data files (which themselves may be directories) normally unknown to any wide spectrum of potential users. This criterion would exclude from this particular function such well-known systems as the Union List of Serials, MEDLARS, the Census, etc., which are large enough and complex enough to require separate development effort. Three general types of data files would be included within the directory system:

1. Quantitative data bases organized and developed for a specific on-going purpose or as a result of continuing experimentation. Examples: Oregon Regional Primate Center; Political Behavior Surveys, University of Michigan;
2. Specialized directories developed to meet a local problem or to satisfy some specialized substantive need. The Technical Information Project, M.I.T., is an example;
3. Specialized collections or directories of nonbibliographic information. Examples: Literary Works in Machine Readable Form, Brigham Young University.

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The purposes of such a directory are obvious: to exclude excessive redundancy in data collection, and to obviate excessive loss of time in locating pertinent data.

A. Directory of on-going research:

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The proposed central store would include only directories and would accelerate the transmission of knowledge about unpublished research information. Input data would include the title, project leader or contact, location, and a short description of work being performed. Progress reports to permit updating would be required.

Advantage should be taken of any on-going or planned facilities. For example, the Science Information Exchange (Smithsonian Institution) operates an automated central store of approximately 100,000 unclassified research projects, primarily in the physical and biological sciences. Approximately 18,000 projects are reported by the U. S. Department of Agriculture covering projects supported directly by the Department, supported by USDA in conjunction with various states, and three-fourths of the state supported agriculturally-related research projects. It can be inferred, therefore, that in addition to the SIE store, additional input to the system will be required if a reasonably complete coverage is to be attained.

B. Directory of Information Network Data:

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One of the central network functions is to create a file of specifications, user experience, availability, cost, etc., of the new information technologies in universities. Such a file would, for example, list a variety of terminals suitable for on-line debugging, for interactive graphic data processing, for graphic display, for keyboard input-voice output, etc. This list of terminals would, for example, include various teletypewriters. The file would contain current specifications, interface requirements, pricing, and delivery schedules about each type of terminal. Most important, the personal comments of many users would be filed, indicating the strengths, weaknesses, maintenance problems, and other know-how which could most profitably be shared by the members of a user community.

In addition to hardware items like terminals, stores, etc., the file would also contain descriptions of what has

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been done and what can be done with the advanced technologies, as well as descriptions of how computers have been used for specified tasks. While the file may be more or less passive in responding to queries by faculty about how computers were used for certain problems, it must be much less passive in teaching faculty members about what use they might make of computers that would not have been possible prior to the development of the new technologies.

Creating and maintaining such a file involves design questions which would give EDUCOM valuable experience. The service provided lies beyond the scope of any single university, hence is a service that might properly be undertaken by EDUCOM. It is unlike a "Consumer Report" or government testing laboratory in that it provides no recommendations, no consulting, no guidance, only filed compilations of technical data. Difficult-to-capture data such as personal evaluations may be more readily submitted to an EDUCOM file than to one under other auspices.

and from a slightly different point of view:

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EDUCOM should operate a file of technical information concerning equipment, procedures, facilities, regulations, tariffs, and the like that pertain to information networks. At a fairly early date, this file should be made available for on-line access through EDUNET. The file itself should be provided with an index and retrieval system. Arrangements should be made for reception of data from on-line terminals through electrical channels and via punched cards, punched tape, and magnetic tape sent in by mail. All submissions should be screened to delete promotional matter, but there seems to be no need to authenticate all technical information before introducing it into the file. It would be better to tag the contents of the file with their degree of authentication, three or four levels of authentication being recognized, and to let the authentication committee increase (or decrease) the level after study. Users should be encouraged to append comments to items in the file about which they have valuable information. The retrieval system should permit users to examine the appended information or not as they choose. That is to say, there should be, in the control language, a simple way of

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indicating whether appended information should be filtered out or allowed to go through to the console.

One of the reasons that the file of information about networks would be particularly helpful is that in the coming years many organizations, including many of the member organizations of EDUCOM, will be acquiring or augmenting informational facilities. The ready accessibility of the proposed file would not only make it easier for them to obtain good information, but would also tend to foster compatibility among their facilities.

C. Directory of network-related activities:

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A file of network-related activities, on-going and proposed, is another data-base enterprise essential to EDUCOM. This file, also, should be easy to put information into, easy to update, and easy to draw information from. The file should provide a framework within which the participants can develop policies and procedures for coherent planning and implementation of a wide range of projects. We do not visualize this file as containing within itself the products of the substantive work described in its register of activities, but we do visualize a system of pointers (cross-reference indicators) that would lead one (or one's computer programs) from the activity file to files of bibliographic information and files of data and models generated by the register of activities. It seems that there is a great opportunity for constructive interaction between EDUCOM and governmental information organizations, especially the Science Information Exchange and the National Referral Center, in the development and operation of the activity file. Most of the federal information services use a search technique in which inquiries are accumulated over an interval of time and then processed together in a batch. "Batching" makes the search efficient because it lets the search program look for several different things at the same time. However, unless the traffic of inquiries is very heavy—very much heavier than it is in any presently operating system—batching is incompatible with rapid on-line service. To make the search process fast enough to support on-line service, a quite different approach is required. In order to begin offering on-line bibliographic access, it may be necessary to operate two systems in parallel: one, a batching system to handle the

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bulk of the mail inquiries, and the other, a system that starts searching immediately upon receipt of each on-line inquiry. The latter system will require elaborate indexing. EDUCOM might well undertake the task of developing the on-line bibliographic and data-base services for a few governmental agencies. EDUCOM would provide to the governmental agencies and their more "advanced" contractors a prototype on-line service, while the governmental agencies continued to supply the conventional service and to maintain the source files. At the end of the period of development and test, operational responsibility would be referred to the agencies and EDUCOM would undertake new research or development projects.

D. Directory of Learning Aids in the Health Sciences:

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This proposal is addressed to the need which health science students have for multimedia learning materials to assist them in their independent study. Presently, rapid access to information on teaching motion picture films, programmed instructional materials, 2 x 2 slide collections, etc., does not exist. Our object here is to permit students to query an I/O device about materials in a specific area (e.g., breech presentation, pulmonary physiology, the neuroanatomy of the visual system) and receive a list of pertinent materials, sources from which they can be obtained, some description of their content, and an evaluation of their usefulness.

To prepare an appropriate data file, students at each of the participating institutions would "catalogue" all materials available at their institutions. Extramural sources would have their holdings added. A form for evaluations would be constructed (a prototype for films has been elaborated in a joint project involving University of Kansas and Western Reserve medical students) and a system developed for adding critical information. Much material would initially have no description or critical comment, but users would be under obligation to supply this so that it would become a part of the data file. The creation of such a file implies purpose and activity shared by students at the participating schools and agreement upon the procedures to be followed.

The above application is immediately implementable. In the future it would be desirable to deliver the learning materials to the student as soon as he requests them, employing a conversational mode for some materials.

E. Location of Experts

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The locating of experts has different connotations in different zones of application. If one thinks of the National Roster of Scientific and Technical Personnel, the image that comes to mind is likely to be that of receiving identical forms from three different professional organizations and, before managing to comply with the request to supply detailed information, finding in the mail three follow-up letters and three more copies of the blanks. If one remembers the Air Force "CATY" experiment, the image is likely to be that of a computer-processable file full of project summaries prepared by laboratory scientists who would rather have been doing experiments than filling out cards with information about their projects.

The system for locating experts should receive its input as a by-product of the day-to-day work of the experts, not from forms completed by them reluctantly or cursorily. In the future, it may be possible to characterize a man's field of interest and competence by examining that part of his creative product that resides in the files of such a network as EDUCOM may one day operate. Citation indexes are perhaps an early step in that direction.

Within EDUNET there will be, because of EDUCOM's transdisciplinary nature, an unusually strong demand for access to experts. Moreover, at least some of the individual participants will be people with genuine interest in contributing to the development of a coherent and useful network of facilities. Therefore, it seems worthwhile for EDUCOM to experiment with developing a file of experts and with techniques for interrogating the file. There are many dimensions within which to experiment. One that suggests itself now is to experiment with a listing of speakers who are qualified and willing to talk about various topics of academic or technical interest. Some of the professional societies have national lectureships for the benefit of their regional or local chapters. Perhaps some of the national lecturers would be willing to make their speaking schedules available through EDUNET. Perhaps, although it would be difficult, it might be possible to arrange some kind of anonymous commentary from their audiences to the file and to make a summary of audience reactions to the listed lecturers available to

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organizations in search of speakers. This line of thought may be more akin to day-dreaming than to preparing a report or a proposal.

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A major contribution of the network to research will be the ease with which it will enable a research worker to call in a consultant on another campus when he encounters a problem which he believes the consultant can resolve immediately. Thus, very able research workers may find themselves participating in dozens of research projects by making significant contributions to them at very small expenses in time—perhaps only a few minutes to hear or view the problem and make a suggestion. In this way a person of great ability generally improves the quality of research in his field at all the institutions of the network.

Toxicological information network. The problem of providing timely information as to antidotes and treatment of the many thousands of poisoning cases reported annually has already been discussed under "needs" (pp. 78 - 79). Here we will first review the present efforts to provide such information—then discuss how a network such as EDUNET could help in providing a solution to the problem.

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There are approximately 550 Poison Control Centers located in communities throughout the United States. There is a National Clearinghouse for Poison Control Centers in Washington, D. C. which is operated within the Department of Health, Education, and Welfare. Local poison control centers are generally operated by county medical societies, teaching hospitals, or other non-governmental associations.

Local poison control centers are staffed by a variety of medical and paramedical personnel who frequently have no special training in this area of specialized information. The National Clearinghouse attempts to provide the local control centers with toxicological information, and the centers submit reports for statistical evaluation to the national office. Local centers in turn transmit this information to local practitioners on request for the treatment of their patients. Most control

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centers rely on standard reference works including in some instances data cards prepared by the central office. Unfortunately, the critical information frequently is either not available, is incomplete, or is misinterpreted by the staff.

Many problems arise in the operation of these local centers, including staffing the centers on a 24-hour basis with competent personnel, training personnel in the use of the reference material, maintenance of up-to-date files, and, all too frequently, failure to submit statistical reports to the central office.

Specifications of a proposed toxicology system: The operating system should be capable of responding with little delay to an estimated two-million requests per year with suitable provisions for expansion of service capability as the population growth and rate of exposure increases.

A. Input to the system would include at least the following data:

1. Identification of material ingested (when known)
2. Time since ingestion
3. Patient identification information (when available)
4. Best estimate of quantity of material ingested (when available)
5. Degree of confidence in above data
6. Signs and symptoms (when needed)
7. List of completed therapeutic maneuvers
8. Identification of person requesting the information and follow-up contact address.

B. Output from the system would include at least:

1. A weighted toxicity rating suggesting the seriousness of the situation
2. Chemical class of the toxic material
3. List of known toxic effects
4. Therapeutic alternatives available
5. Special precautions involved in therapy
6. Tabulation of special facilities and their location indicated for treatment of special cases
7. An identification code assigned to the case to be used for further inquiry.

It is presumed that many special situations will arise in which a straightforward input-response sequence could not occur. A special mode of operation of the

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system would be required, for example: (1) if the material ingested is unknown at the source; (2) if there is an inconsistency in the input data; or (3) if the requested information is not contained in the data base.

As another function, if certain noncritical information were not provided at the time of the original request, the system would automatically request such data from the source to complete the transaction when the emergent situation was over. In some instances this could be accomplished by mail; in others, by telephone. Such data would provide the basis for scheduled or demand statistical reporting of pertinent conclusions.

Regardless of other considerations, the dominant operating characteristic of this system is that any physician, and perhaps any other concerned person, at any place in the United States, will have immediate access to the data bank on a twenty-four-hour-a-day basis. The criterion of necessity requires that certain elements of the system be decentralized, and that the failure of any one element of the system not incapacitate the network.

It is assumed that requests for information from this system will originate from two classes of users distinguished by their professional training. Accordingly, the input to the system and the response of the system must be consistent with the level of understanding of the user. For this reason, ordinary telephone conversation is considered the most appropriate medium. Since it is necessary that this sytem be computer based, it is implicit that there exist a point, or points, of translation from telephone conversation to machine compatible data.

It is proposed that a nationwide telephone network be established to provide access to the points of translation. Furthermore, a communications network between points of translation and decentralized computer-based-information-stores is required to handle information loading during peak periods and to provide fail-safe operation in the event of breakdown. It will be necessary to evaluate the time distribution of occurrences as presently reported to the National Clearinghouse of Poison Control Centers to determine the required number of intermediate translation points; similarly, an engineering analysis is required of the number of computers needed to meet the fail-safe criterion. These analyses must be predicated upon an acceptable maximum queuing. While

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several computers may be required to meet the fail-safe criterion, one center must exist to update the data for the entire system, to provide summaries of each input and case history and to develop the statistical analyses.

Telephone network: The telephone was designated as the medium of the primary input for the reasons that it is almost universally available to the inquirers of the system, its operation is understood, and it provides a reactive mode with the data translation points. One of the possibilities is that a nationwide WATS line be established; any person then has access to the WATS line by dialing one telephone number; all billing is to the system and its users have access to all toxicological data at no charge.

Translation stations: Each translation station must be staffed on a twenty-four-hour-a-day basis with at least two individuals. Several trunk lines from the primary telephone network would feed into each translation station. Each station would be equipped with a minimum of two input-output terminals to the computers. This feature improves the queuing situation and provides hardware backup as well. It is proposed that each of these terminals consist of an alpha-numeric keyboard which produces hard copy of all information transmitted and received, and a visual display device such as a CRT display. The visual display is required to provide for immediate output communications from the computer in critical situations; such a display unit would also permit the transmission of graphical data where such might be appropriate. Each station would also require a high-speed printing device to document the entire communication.

Data storage facility: It is apparent that the data storage facility must operate on a time-sharing mode among the several translation stations. The data storage facility must be capable of dialogue communication with the translation stations; considerable flexibility of formating ought to be possible to permit varied sequences of input data and differing input vocabularies.

The data storage facility must contain a thesaurus of toxicological agents, which would provide information concerning chemical contents of proprietary products as well as a cross-indexing of those products by brand names, household names, etc. There must be on store a

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functional tabulation of clinical information operationally related to individual toxic materials and classes of materials. There must be on store a tabulation of therapeutic procedures for each toxic substance and class of substance. The data storage bank must be able to operate in a probabilistic mode where sufficient data cannot be obtained to specify the toxic agent precisely or in circumstances in which alternate therapies are possible.

The data storage facility must be capable of initiating inquiries to the translation stations when inadequate source data are presented to it; adaptive elements must be provided to permit the data storage bank to modify decision programs on the basis of performance and new data.

The system must be capable of generating summaries and of providing the inquirer with a complete hard copy record of the input and output data. Similarly, the system must be capable of generating scheduled and demand statistical analyses of its operation.

Health Services Information Network: From the prototype poison control network the group evolved a generalized Health Service Information Network. It was agreed that the prototype network possesses the characteristics of the generalized system and would serve as an adequate working model which could be expanded.

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The major unexplored area in the prototype network, as described, was that which related to the generation of the data for the data bank. For the generalized system the following characteristics were developed.

The fundamental concept is that EDUCOM, by utilizing the intellectual resources of the academic community in an organized fashion, will provide the basic data for the Health Services Network. It is anticipated that the organization of the Poison Control Network will generate experience for further expansion in the area of other health services.

It is proposed that EDUCOM organize panels of research specialists in each of the subject matter areas of the Health Service Network; for example, in the prototype Poison Control Network, panels would be organized for each of the major classes of poisons. The members

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of each panel would be nominated by universities and selected by EDUCOM. It is proposed that no more than one person from any university be a member of any given panel. EDUCOM would also be able to select panel members from outside the universities in special instances. Each panel member would be tied into the Network system by an individual console and, by means of conference telephone calls, would be able to confer with other members of the panel. Each panel member, via his own terminal, would have access to the EDUCOM constructed MEDLARS storage bank and to governmental research files. The panelist would then develop the basic data in his subject matter specialty in cooperation with specialists who would encode the data and develop retrieval programs. Before such data would be available to the physician, the appropriate panel members would be required to analyze the response of the system and release the data. Each member of the panel would be provided with current data on the questions in his specialty being asked of the system by the physicians, and the answers given by the system to these questions.

Panel members would confer with each other via conference telephone calls outside of the Health Service Network; each panel member would be equipped with some means of visual communication with the other panelists such as slow-scan television. It is proposed that the members of the panel serve for a fixed term and that their work on the panel require no more than twenty percent of their working time.

As the result of questions asked of the system by inquiring physicians, which the system is either unable to answer or to which alternative answers may be appropriate, the data storage bank will be up-dated. In emergency situations, in which the required data are not available in the network, the computer will automatically route inquiries to a member of the panel with expertise in the area.

Thus, the role of EDUCOM in the generalized Health Service Information Network, and more particularly in the Poison Control Network, is the development of specialized knowledge and the insertion of this knowledge into the system in such a form that it provides timely answers to those who inquire of the system. EDUCOM would define the subject matter specialties and select the

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> panel members in each; it would supervise the encoding of the source data developed by these panelists and the manner by which these data are inserted in the system; it would develop follow-up programs designed to test the efficacy of the answers provided and statistical analyses of the data; and, perhaps most important, it would provide motivation for specialists to contribute their expertise to Health Service Information Programs through the universities with which they are associated rather than via channels foreign to these universities.
>
> The Poison Control Network is only the first step, a working model to test the potential of the system. The next logical step is that panelists prepare capsule summaries of the latest developments in their specialties and that these summaries be inserted into the system.

Bibliographic services and information centers. The possibility of bibliographic service in a communications network was extensively explored during the Summer Study from such points of view as:

a. adapting present computerized bibliographic systems,
b. developing discipline-directed or profession-directed services,
c. developing a computerized Union List of Serials, etc.

A number of information centers offering bibliographic service as a primary function are in various stages of planning or development. Therefore, in this section, we will consider EDUNET as a channel for interactive access to information centers, including bibliographic service.

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> A large number of bibliographical services are in process of becoming automated. MEDLARS, Index Medicus, Chemical Titles by Chemical Abstracts Services, American Society for Metals Documentation Service, NASA Scientific and Aerospace Reports, etc. There were forty-six such bibliographical services in various stages of automation identified in the Summer Study. Many bibliographies are on tapes but are not structured for interrogation.

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If they are to be a part of EDUNET, some degree of structure is needed for bibliographical files so that on-line interrogation can be carried out or, at least, so that there is a fast enough turn-around time to make the service much faster than mail. A Task Force of EDUNET should be screening potential bibliographical files, particularly with regard to the above capacity for direct use. When a file of interest to a substantial group of people on the net has qualified, it should be attached in one of three ways: (1) direct communication from EDUNET to resident bibliographical storage files such as the Chemical Abstract Files at Columbus, Ohio; (2) files stored on one of the EDUCOM participant's computer systems and made available to EDUNET by that node; (3) files stored in EDUNET central storage file.

It is suggested that method 1 or 2 be used initially, and that method 3 be introduced when the cost is warranted. With growth in usage of certain files such as Chemical Abstracts at the graduate student level, each participating node may need to have the file in storage; and the function of EDUNET would become that of updating such a file.

A particular information system based on a machine-readable copy of the Union List of Serials was proposed.

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The proposed system would include only directories and would transmit information concerning location of specific serial titles holdings, available bibliographies and lists, and specialized book collections. To attempt to add all three types of information resources immediately would be an impossible task. It is recommended, therefore, that EDUCOM concentrate on assuring a location directory of serial holdings, with the resources themselves furnished by the supplier.

This could be accomplished by keypunching or machine reading the Union List of Serials, with updating the responsibility of the operating group, possibly partially supported by EDUCOM. It is anticipated that the mechanism would serve a broader user group than EDUCOM members. Benefits of this form of operation are not only on-line use but also print-out at any time for dissemination.

An Association of Research Libraries Committee chaired by Fred Wagman, University of Michigan, has

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recently been appointed to work with the Office of Science Information Services (National Science Foundation), the Library of Congress, and other groups in an effort to expedite the development of a computerized current list of serials and a union list. It is recommended that EDUCOM work with the ARL committee to avoid duplication of effort.

The relationship of EDUCOM to the development and operation of the mechanism for the list of serials must be determined. However, it is suggested that liaison for such a project should be provided by a full-time EDUCOM staff member; and a continuing committee, representing diverse interests and disciplines, should be appointed to advise EDUCOM on policies, standards, etc. Systems analysis and operations personnel should be the responsibility of the contractor. Keypunching, machine reading, or other means of input of records, and programming personnel would also be required in order to create the system.

At present, with the published Union List fairly up-to-date, the benefits of an automated serials directory may not be apparent. However, as time goes on, the published List will become less current and much more difficult to utilize. With the proposed system, the time consumed in searching for essential information can be reduced.

In parallel with this development, smaller networks should be encouraged to link systems for local resource exploitation. This could lead to cooperative acquisitions and processing.

The possible size and cost of the task of obtaining a machine-readable copy of the Union List was indicated in another paper.

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The 3rd edition of the Union List of Serials has just been published. It is in six volumes, contains 156,449 entries and 70,538 cross references, and lists the holdings of 956 cooperating libraries. All titles listed are those that began publication before 1950. The first supplement to the Union List appeared previously in the form of a ten-year cumulation of New Serial Titles, covering titles which began publication in 1950 or later. A second supplement, also in two volumes, covers titles

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appearing in the four-year period 1961-1964. Annual volumes and monthly issues of New Serial Titles are available since that time.

Only the material in the ten-year cumulation of New Serial Titles was originally in machine readable form (punched-card file). Whether this punched-card file still exists is not known. The repunching of this tremendous file of material would be a gigantic task in itself. Even if only the holdings of EDUCOM universities were represented (which is a somewhat dubious proposition, if maximum utilization of national resources is to be obtained), the punching and editorial tasks are still very large. (In this connection, the suggestion of Messrs. Taylor and Pierce is recorded here: if a ULS is to be undertaken, Mr. Rabinow should be queried as to his charges for an optical scan of the published work.)

As noted before, there are a large number of bibliographic services so that even if use of the Union List of Serials should prove to be a task of insurmountable size, alternative data resources are available.

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In general, the nationwide systems of interest here can be considered in three groups:

1. Federal Systems—e.g., Science Information Exchange, National Library of Medicine (MEDLARS), National Referral Center, Federal Clearinghouse for Science and Technology. Many agency information systems, interlibrary loan systems, Smithsonian International Exchange, National Data Centers, etc., can also be grouped here.
2. Nonfederal, Nonprofit—e.g., Chemical Abstracts, Biological Abstracts, Excerpta Medica, etc. Most specialized information centers belong here.
3. Nonfederal, Profit—e.g., Institute for Scientific Information (Philadelphia, Pa.), "Citation Index," and "Current Contents."

It should be brought out that information systems can be and are classified along several other lines, such as the traditional distinction between "published information" and "unpublished," the latter including descriptions of on-going research, completed but unpublished data, conference schedules and programs, personnel information, etc. The term "current awareness," as applied to

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information systems, is unfortunately no guide to the currency of the material—the term is used for published work which may be several years old.

The types of output provided for interchange, as described in this paper, may include one or more of the following:

Permanently bound books
Paper bound books
Single sheets of summary material
Telephonic responses
Computer printout
Xerox, thermofax, or other facsimile reproduction
Computer tapes
Punched cards
Microfilm (in many forms)

The individual systems themselves range from completely manual to semiautomated status; some, which might be completely automated, have chosen, at least at present, to retain both manual and computerized methods of retrieval pending further cost analysis studies.

Resources available from Chemical Abstract Service and from the Institute for Scientific Information were described in more detail as an alternative to the Union List of Serials.

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1. *Chemical Titles*

A KWIC index covering titles of 100,000 journal articles each year, taken from 725 journals. Words in title, authors' names, and coden (abbreviated journal title) are searchable; programs for IBM 1401 or IBM 360/40 are available, embodying simple and/or/not logic, and ability to use word fragments in prefix or suffix mode or both. Tape increments are furnished every two weeks; subscription price, $1500 annual minimum, rising to ceiling of $2200, depending on numbers served.

2. *Chemical-Biological Activities*

Article citations with digests are available (a digest is a particular kind of abstract, written in a stilted, stereotyped mode, with effort toward standard terminology); also available are KWIC indexes of titles *and* every line of the digest; also a molecular formula index. The service began in 1965 when 8800 digests were published.

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The estimate for 1966 is 12,000 digests from 550 journals. Authors' names, journal titles, words in title or digest, molecular formula, and registry number are searchable; programs are available for IBM 1401 and IBM 360/40. Tape increments are furnished every two weeks; subscription is $1300-$2000 per year.

3. CAS Registry

Beginning with Vol. 62 (1965) of Chemical Abstracts, a computerized file of organic compounds was established. A given record in this file consists of a structural representation of the compound, a unique registry number which is assigned to it, all of the names by which the compound is known, and references to the abstracts in CA (by volume and column number) which describe the compound. By May 1966 there were 324,000 unique structures in the file, with references to 471,000 articles describing them. The impression is that the file is growing by 5000-8000 structures a month, with approximately twice that number of references. The file is searchable by substructure as well as by full structural representation, by name (average of four assigned to each structure), and by registry number. At the present time, these tapes have not been made available for purchase. (Reference: "Installation and operation of a registry for chemical compounds," J Chem Doc 5:238-42 (Nov 65).)

4. Polymer Science and Technology

Beginning in January 1967, CAS will issue Polymer Science and Technology, on the general plan of Chemical Biological Activities, but somewhat larger (11,000 digests per year from 425 journals).

5. Chemical Abstracts

Chemical Abstracts itself is not now in machine-readable form (except for some few indexes—but not the formula and subject indexes). CA printed 208,500 abstracts last year. There are plans to have it in computer form (of the digest type) by 1969.

6. Other

All CA abstracts, since the beginning in 1907, are now on microfilm. (Weil B: "Esso research experiences with CA on microfilm," J Chem Doc 5:193-200 (Nov 65).)

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Comment: The above information was furnished by Mr. Edlin G. Johnson of the Marketing Division of CAS, in a telephone conversation with Rogers on 7/26.

Chemical Titles does not look like an attractive prospect. Chemical-Biological Activities, the forthcoming Polymer Science and Technology, and the CAS Registry might be prospects. They are not as attractive as Chemical Abstracts itself would be, if available, for they deal with relatively limited fields; whereas CA itself is of interest to physicists, biologists, and pharmacologists, as well as chemists and chemical engineers.

SCIENCE CITATION INDEX

The Science Citation Index was published on an experimental basis in 1961 and began regular publication in 1964. The volumes contain, in addition to the citation index proper, a listing of all the citing articles, called the SOURCE INDEX, which gives full bibliographical details (but no subject tracings). Patents were listed through 1965; they have been dropped in the current year. The following table indicates the size of the operation:

	1961	1964	1965	1966
Source Journals	613	700	1,147	1,304
Source Journal Articles	151,639	151,639	235,801	300,000
Source Patents		47,703	60,492	
Total Source Items		199,342	296,293	
Source Authors Specified		381,195	576,392	
Citations to Journal Items		1,424,947	2,144,103	
Citations to Patents etc.		703,166	1,191,957	
Total References Cited	1,400,000	2,128,113	3,336,060	3,500,000

1. Science Citation Index

The SCI proper is available on tape, at a cost of between $15,000-$24,000 per year. In tape format, the records exist in "citation pairs"—the cited articles and the citing article, each half of the pair being an abbreviated record about fifty characters long. These would ordinarily be searched by cited author or by a particular cited reference.

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2. Source Index

The source index is available on tape, at a cost of between $5,000 and $8,000 per year. Records are from sixty-six characters to a maximum of two hundred, forty-six characters in length. Fixed fields occupy the first seventy-four characters; they indicate the primary source author, source journal and volume and page, the year of publication, and the number of secondary authors. Field seventy-five through two hundred, forty-five names secondary authors and gives the full title of the paper. Programs are available for the IBM 7074, which search titles word by word, by word fragments, and by authors' names, using and/or/not logic.

Comment: The above information was furnished by Dr. Eugene Garfield, Director of the Institute of Scientific Information (which publishes SCI), in a telephone conversation with Rogers on 7/26. It has been supplemented with information from the introductions to the various SCI series.

The Source Index alone does not look like a promising application, because the type of search required is so typically one that lends itself to serial (batched) searching. It could be inverted, but at considerable cost, and the and/or/not logic would still be in a serial mode (probably). On the other hand, the Science Citation Index does look attractive, particularly if combined with the Source Index, so that full titles of citing articles could be shown. The defect would be that the search strategy would be limited to cited articles and authors—but experience has shown that the cited article is indeed usually a highly effective subject search handle. The very prominent advantages would be: (1) wide coverage and interest—biology, chemistry, physics, behavioral sciences, sociology; (2) excellent promptness of "indexing."

Foster and Hersey provided an illuminating description of some of the Federal Information Analysis Centers:

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By way of illustration, let us compare the published information concerning three Federal National Scientific Information Centers; namely NRC (National Referral Center), CFSTI (Clearinghouse for Federal Scientific and Technical Information), and SIE (Science Information Exchange).

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Most of the science and technology information activities in the Federal sector are in the executive branch of the government with the two notable exceptions of the Government Printing Office and the Library of Congress. The Office of Science and Technology formulates policy and plans, gives other support, and is responsive to the advice of the Federal Council on Science and Technology. At the pleasure of the President, the Office of Science and Technology can issue directives to all other groups—subject to the approval of Congress when money and significant changes are involved. However, the directive approach is rare; the usual procedure is to operate by staff committee work and informal cooperative procedures. The director of the Office of Science and Technology is also chairman of the Federal Council on Science and Technology (a 1959 legislative act). The Committee on Scientific and Technical Information, formed in 1962, is an advisory group composed of federal administrators in science (just as the Federal Council on Science and Technology is) and supports the Federal Council on Science and Technology in planning and advising with respect to information system requirements and developments. The Committee on Scientific and Technical Information has published an analysis of and recommendations on federal information centers.

NRC and SIE are classified as Information Analysis Centers and the CFSTI as a Publication Announcement and Distribution Center. There are about 300 major information analysis centers in the United States. These organizations perform specific analytical tasks. Typical products of information centers are analytical reports, written by specialists on the Center's staff, and, especially, manipulated data summary reports, prepared through manual or automated procedures.

Let us examine the three information centers in more detail. The National Referral Center for Science and Technology, administered by the Library of Congress, but supported by the National Science Foundation, makes available to the public those sources from which information can be obtained. It may be regarded as a switching point—or, as its name indicates, a referral center—in the network of scientific information centers. The capability of this Center lies in its being able to refer a requester to other information centers that compile and

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categorize the specific type of information he may require. The service of the National Referral Center may be requested by any individual or organization working in a scientific or technological field, free of charge. The Center does not answer technical questions directly, nor does it provide bibliographies.

The next information center, the Clearinghouse (CFSTI), is more specifically classed by the COSATI Report as a Distribution Agency which distributes a pool of unclassified report literature offered for public sale; a translations announcement journal; a supporting Index to available government reports; and text of abstracts on perforated tape. The enabling legislation for the CFSTI is broad in terms of the audience to be served and the functions to be performed.

One of the major portions of the CFSTI collection is the report literature from the Defense Documentation Center constituting unclassified reports from military organizations and defense contractors. Their budget is more than $5 million, half of which is transfer funds from other agencies to support CFSTI in announcing and redistributing reports prepared by, or in the interest of, these agencies. For example, the CFSTI handles comparable report literature from the National Aeronautics and Space Administration, the Atomic Energy Commission, and thirty other Federal agencies.

CFSTI acquires only scientific, technical, and engineering reports resulting from efforts supported by federal funds. Depending on the treatment given at the source agency, an input report may be reanalyzed for CFSTI cataloguing, or the material provided may be reviewed or modified as appropriate to conform with CFSTI formats. Input is microfiched or microfilmed and analyzed; and abstracts are produced on tape perforating equipment for publication in DDC's TAB publication or in CFSTI's U. S. Government Research and Development Reports (USGRDR). CFSTI also distributes the overrun of scientific and technical information published by the Government Printing Office for other agencies—acting as a bookseller at the prices assigned by the GPO. CFSTI prepares bibliographies on a contract or fee basis. It also initiates certain bibliographies that may be considered to be price lists or secondary announcement media on comparatively popular subject areas for the

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basic report literature store. The current annual rate of translations and foreign reports is over 2,500. It also announces and covers by indexes over 20,000 patents per year, which are of interest to industry.

The CFSTI carries out some referral functions, and in this, it cooperates with the NRC.

The CFSTI publishes in USGRDR, titles of Research in Progress which announces on-going government development projects in physical sciences. Such information is obtained from SIE. However, the SIE has not attempted to serve the general public as has CFSTI. In this respect, there are cooperative agreements between SIE and CFSTI.

The COSATI study indicates that CFSTI is interested in the following: (a) a single source of information on government reports for industry and the technical community; (b) compulsory registration with CFSTI of significant translations made or planned by any federal agency, in order to develop a closer control and interchange of the translation effort; (c) a separate journal for the announcement of patents.

The Science Information Exchange (SIE), founded by several government agencies sixteen years ago and presently administered by the Office of the Secretary of the Smithsonian Institution, and supported by NSF, receives, organizes, and disseminates information about current scientific research. Its basic mission is to provide information for planning and managing research activities supported by government and nongovernment organizations. It promotes the exchange of information concerning current research and focuses on the prepublication phase, the information gap between the time a research project is initiated and the time its results become generally available in a publication. As one of the oldest centers concerned with current research in the prepublication stage, its primary purpose is to avoid unwarranted duplication of research effort by providing a tool for research management purposes.

SIE acts as an information center or special library. Notices of Research Projects, each containing the title, research investigators, funding, locations of work and period of time, and a 200-word technical summary are analyzed, indexed, processed, and stored in computer

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(IBM 360) and manual files, so that many items relating to questions about projects can be quickly retrieved. More than 100,000 records have been established and over 35,000 requests are processed annually.

Other federal information centers and libraries were also described. For example:

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The U. S. Office of Education is implementing its ERIC System. Twelve individual ERIC Centers have been funded and have started to operate. Most of these Centers are at universities. One, however, is at the Center for Applied Linguistic Research in Washington, D. C. Groups have been funded for a period of eighteen months. It should be expected that as more funds become available and as the system survives its initial shake-down test, other ERIC units will be started. ERIC Central will have the individual ERIC units collect, index, and provide a 250-word abstract for individual papers collected in their fields. To avoid a complete duplication of the library systems of America, all papers collected by the individual ERIC units must have educational significance.

Each unit will cut a flexowriter tape which contains the significant citation information, indexing information, and abstract information for each paper collected.

Through central processing, the more significant of the collected papers will be made available in Washington. The full collection of documents, however, is announced in periodic bulletins, the first of which is "Research in Education" available through the Government Printing Office, and the full text of all documents is available through the ERIC document information service at Bell and Howell. Individual ERIC units may, if they wish, use the university facilities for implementing information retrieval on the data they have collected. Such a net would readily be exploited by the educational institutions of this country through an EDUCOM network. The U. S. Office, due to its eagerness to see such information disseminated, would probably cooperate in having the individual ERIC Centers work through the network, providing that such network inclusion neither endangers the initial goals that the U. S. Office has set for its ERIC net nor puts an undue burden on the funding. Such a burden endangers the inclusion of the other educational

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areas in the network. The twelve already existing ERIC units as yet fail to cover the full field of education. The U. S. Office is anxious to remedy this situation.

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The National Agriculture Library, renamed in 1962 after one hundred years of national service as the Library of the U. S. Department of Agriculture, acquires, maintains, and disseminates information on agriculture and related sciences. Its holdings, collected from over 150 countries and jurisdictional entities, total more than 1,250,000 volumes, including outstanding collections in chemistry, biology, entomology, apiculture, agricultural law, and soil, plant, and animal sciences.

In addition to the traditional functions performed by a Library, the Director of the National Agricultural Library has been assigned responsibility by the Secretary of Agriculture for issuing policies and coordinating all scientific and technical information activities of the Department of Agriculture.

A resumé of on-going activities which may be of interest to EDUCOM participants follows.

At the request of the Director of the Library, a Task Force for Agricultural-Biological Literature Exploitation was established, using in-house competences of the Department of Agriculture and representative from other federal agencies and land-grant institutions. Their report, containing a complete analysis of the Library's functions and activities, cost and user studies, and recommendations for future automated developments and applications, was issued in March, 1965. The ABLE recommendations have become the blueprint for automation of the functions of the National Agriculture Library.

Emphasis is being given to developing a basic authoritative agricultural/biological vocabulary for information storage and retrieval of published literature and unpublished research information. It will serve the entire Department of Agriculture, any other government agency which has interest in these subjects, and the land-grant colleges and universities. In November 1965 the first agricultural/biological Subject Category List was published. The List consists of fifteen major fields which are further divided into ninety-eight groups similar in structure to the COSATI (Committee on Scientific and

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Technical Information) Subject Category List. This framework provides subject approaches for both published literature and unpublished research reports by manual or machine methods. Library staff members from four land-grant universities (Pennsylvania State University, Purdue University, Massachusetts Institute of Technology, and the University of Wyoming) assisted the Library from March through June in arriving at basic terms. Before the end of the summer automated print-outs by subject category will be available. Scientists in each of the major disciplines covered by the vocabulary will evaluate the terms. At the same time such specialized lists as taxonomic names and chemical substances will be developed. The basic vocabulary will be issued in June 1967.

The Bibliography of Agriculture is a comprehensive listing of substantive agricultural materials issued monthly by the National Agricultural Library. Beginning with the August 1964 issue, the monthly author index has been issued by using an optical scanner-computer combination. Computer programs for the new monthly subject index have been written and are now being tested. The annual December index issue, heretofore produced manually, will be produced with the optical scanner-computer combination. Monthly subject indexes, with automated annual cumulations, are expected to be available in 1967. Mechanization of the citations themselves, as well as the automated production of a List of Available Publications, is scheduled immediately thereafter.

A Pesticides Information Center was established in the National Agricultural Library early in 1965 to provide support to the Department's research program on pests and pest control. Datatrol, Inc. is developing an operational system, which is expected to be available late this year. Present plans call for actual installation and operation of the system, to include published and unpublished information and evaluated data, in 1967. The target date depends upon availability of funds and progress of the agricultural vocabulary. In the interim, the Library continues to issue the biweekly Pesticides Documentation Bulletin, using the Key Word Out of Context program.

A contract has been let by the Department of Agriculture to Documentation, Inc., to develop a mechanized

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system for storing and retrieving information concerning current agricultural research projects. Projects include those being performed by Department of Agriculture personnel, by cooperative agreements between USDA and the states, and roughly three-fourths of those performed by the states and supported by state funds only. The system is expected to permit retrieval of management-type information as well as scientific and technical information. The system is to be compatible with those currently operated by large research agencies of the government and is being developed in cooperation with the National Agricultural Library. It will utilize a common vocabulary.

A recent survey of land-grant institutions showed clearly that there is a trend in agricultural libraries toward use of the Library of Congress classification scheme. The Library changed to the Library of Congress schedules in January 1966, resulting in two of the three national libraries using the same system, and making it possible for other libraries to utilize the cataloging performed by the National Agricultural Library.

The Dictionary Catalog of the National Agricultural Library, 1862-1965, is scheduled for publication during 1967. It will cover the complete holdings of the Library for the period shown, will be issued in sixty-eight volumes, and will be available from the publishers, Rowman and Littlefield, New York, at an estimated price of $952 per set. The Dictionary Catalog will be released in 10-volume lots, the first ten to appear in the spring of 1967, with the last group available before the end of the calendar year.

Current additions to the Library are recorded in the National Agricultural Library Catalog issued monthly by Rowman and Littlefield at $7.50 per month, or $72.00 per year. Volume 1, No. 1, January 1966 was published in March. Beginning with the April 1966 issue, the size of the print has been enlarged. The alphabetical section of this catalog is accumulated quarterly.

A start has been made toward the establishment of a Rare Book Division. A staff member, after consultation with the Library of Congress Rare Book Division and the USDA historian, has begun a systematic survey of the Library's total holdings. A listing of rare works in the field of general agriculture is being compiled. This

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list—the first in a proposed series—will be given wide distribution for comments as to its utility and suggestions for improvement. Tests of methods for restoration and fine rebinding are also planned.

Responses to Task Force ABLE questionnaires indicated that staff located in the field were frequently ignorant of National Agricultural Library services and how to obtain them. Consequently, a draft of a proposed information booklet, describing not only NAL services but those of other government agencies concerned with agricultural information, was prepared and sent to selected field personnel for their comments. The response was most favorable, and the information booklet will be available for distribution later this month.

Work on plans for an agricultural library network is continuing. A questionnaire was mailed to 158 land-grant colleges and universities and agricultural experiment stations to enable the Library to gather opinions and preliminary data on possible areas of future cooperation. The responses are being considered in developing long-range plans for an agricultural network. The questionnaire covers the following areas:

1. Possible assumption of nationwide responsibility for acquiring and servicing all state, county, and other publications of their respective states;
2. Formal agreements under which national responsibility for specialized collections is assumed by state institutions;
3. Extension of National Agricultural Library clearinghouse activities;
4. Expansion of information to land-grant institutions concerning publications exchange resources;
5. Utilization by state institutions of tapes provided from a National Agricultural Library mechanized system;
6. Cooperation on the Agricultural Vocabulary Project;
7. Extent of state institutions' services to USDA employees within their states;
8. Library services briefings to state employees going overseas; and
9. The use of a publication or another medium of communication to publicize new services and operations.

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Another fairly elementary project is essential to a network involving cooperation with industry and other private organizations. An inventory of agricultural information resources throughout the country is being prepared. Over 340 have been identified within the Department of Agriculture alone. Attention is now directed to other governmental, academic, industrial, and historical institutions. This not only will identify potential components of a network but also provide the bases for referral activities. The Library hopes to eliminate unnecessary duplication, to expand essential areas, and tailor future activities in accordance with recommendations made in the COSATI national plan. National Referral Center Directories and other reference works are being used to compile a directory of U. S. agricultural information resources for this purpose. Printing and distribution of the directory is expected by mid-1967.

In addition to all of these resources is the National Library of Medicine and its MEDLARS activity. This has been discussed earlier as a schedulable, noninteractive application. MEDLARS can undoubtedly be used in an interactive and unscheduled mode on a national communications system but there are some questions whether this should be an early responsibility of EDUCOM.

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It has been suggested that the MEDLARS files be inverted and placed in a direct access store. While this would be an interesting and useful (and costly) experiment, it is open to the objection that the experiment is probably about to be performed elsewhere. The SUNY project at the Upstate Medical Center (Syracuse University) is now getting underway, with a central computer store in Syracuse and lines to the Medical Centers in Buffalo and Brooklyn; the project will establish on-line access to the catalogues of the three libraries and, if possible, will include the most recent year's MEDLARS indexing in the same store.

At the same time, the National Library of Medicine is surveying MEDLARS with an eye to improvements, and it is possible that NLM itself contemplates inversion of the file (and possibly time-shared interrogation over long lines).

A description of the use of major library resources in a medical environment has been given by Wright.

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> As part of its work in continuing medical education, EDUCOM must supply a dynamic library resource-sharing capability to network participants as well as remote terminals for querying and image transmission for physicians and small community hospitals that do not have library resources available.
>
> Its major capabilities in the library area must include reference services, i.e., bibliographic searches; supply copy of the requested materials in video or hard copy in the format requested; alerting/profile services that must be continually updated; cooperation in the development of local and national union lists of serials and books in machine-readable form to facilitate the location of requested materials.
>
> Now that extensive computer-based medical library services have been proposed in some detail, we must develop a method for making such centrally located services available to a remotely located physician on a local-access basis. This has very strong implications for user-oriented software, and the "case study" presented here has this in mind. The particulars, of course, are left up to the software designer, but the type of access necessary must be the guideline.
>
> For the doctor in these remote areas, entry to the system must be simple. For example, he will walk into the terminal room and sit down at a teletype console. Instructions in hard copy will be attached to the console instructing him in how to make initial contact with the system. In cases where this terminal acts as the entire library of a small hospital or local medical center, this may consist of merely turning on the console. In this type of installation, full-time operating personnel will be nominal or nonexistent.
>
> Having made initial contact, the doctor (nurse, therapist, etc.) will request a service. Suppose he requires a bibliography on a particular subject. If he does, a standard nomenclature probably must be used. A hard copy thesaurus needs to be available at the terminal for this to be practicable. With the request transmitted to the library system, the system now takes over and presents the regionally available bibliography to the requester

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either in hard copy on the teletype, on video, or both, as he may request. The system can make this more meaningful and useful if it presents the citations in a statistically determined order on the basis of previous frequency of requests for abstracts and hard copy of the full documents. If at any point, the user thinks he has found what he wants, he stops the search and checks the abstracts or complete documents as he wishes. If he is wrong, he resumes the search where it terminated.

When the user has found a reference he wishes to pursue, he cites the reference to the system and requests either an abstract or complete document which is supplied either from the computer memory or by switching on video and transmitting images from an automatic microfile retrieval system or document reader.

Suppose, further, that the user has found an item of interest. He may either take notes from the display or request preparation and transmission of a hard copy which can be sent either by mail or over the wires during slack time. In the latter case he may determine the expected delay by typing "DELAY." The system will respond accordingly.

If an emergency is involved, the user may not have time to wait for hard copy to be mailed. In this case typing "EMERGENCY" or "NOW" will cause the system to display the document for copying on video and allow photography by, for example, a large-format Polaroid process. When the user requests emergency service, a simple check should be made to determine that there is a definite emergency so that this service will not be unduly exploited.

Should the immediate regional sources be exhausted and the user not be satisfied, by typing "MORE," he can be switched automatically to the national center which will use its master bibliographic index to switch him to the next nearest regional center and initiate further search. This process can continue until either the user is satisfied or the resources of the network are exhausted.

Assuming that the user has a particular article or book in mind, he can request that specific item rather than going through an entire bibliographic search.

The user may also request an alerting service or profile service with a specified frequency which can be filled at the required times by the system.

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> A browsing service could best be implemented by an automated card catalog of some sort. This is clearly a low-priority service and should be able to be switched off if more urgent matters require attention by the system.
>
> If the regional system is completely busy with priority searches, etc., it should automatically switch new priority calls to the national net for rerouting.
>
> If the requesting physician is remote from the terminal, in cases of urgency he may request these services by phone from the operator at the terminal.

It is certainly clear that a vast amount of information from information centers and libraries is available and that many of the participants at the Summer Study were eager to use parts of this information as data bases for bibliographic searches and retrieval projects. Also, it appears that present technology is capable of accommodating the demands of many of these data bases in a communications network. Still, in most cases, the effort required to solve questions of standardized formats, to get information into machine-readable form, to develop instructional techniques so that the uninitiated can make reasonably successful queries, to invert files, etc., is equal to the amount of information involved. While large scale data bases in a network offer an exciting vista, their development is no small task and should be approached as a major undertaking.

Sharing of computer resources. This subject has been touched on in various other parts of the report (e.g., section on data base applications). Nevertheless, it is a sufficiently fruitful application of a network that we give it explicit attention.

Computer resources are taken to mean computers themselves, programs for computers, and data bases on which the programs operate. These resources can be shared in the following ways:

1. When the computer is available locally, one may use programs and data bases residing elsewhere in the network.

2. When the computer is not locally available, it may be accessed via the network:

   a. using programs and data bases residing elsewhere,

   b. or using user supplied programs and data as in the debugging and testing of new programs for remote facilities.

The dissemination of computer programs to remote users was discussed in the following paper.

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Selfridge
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One of the most obvious and attractive advantages of a cooperative computer network is the sharing of the computer programs. There is, of course, a wide range of meanings and implications embodied in that, and the purpose of this paper is to elaborate a little on them.

There have been, and still are, cooperative user groups for computers. The best known is SHARE, an organization for IBM machine users; but most of the other computer manufacturers support cooperative programs also. On the whole, these organizations are not completely successful. Some of the reasons for this can certainly be corrected with the kind of network that ought to be produced by EDUCOM. There are other difficulties that do not seem to be so easily alleviated.

Generally a participant in SHARE broadcasts his successful programs (or subroutines) in a printed form consisting of at least a technical write-up, a listing, both symbolic and machine code, and a set of instructions for using the program. It is quite true that the average programmer is extremely reluctant to write anything up at all, and his notion of what constitutes instruction is fairly primitive. We do not see that EDUCOM can influence this easily. If anything, it can help by lowering the standards of what a write-up should be, by supporting an interactive questioning that will require very little literary creativity from the programmer.

There are several kinds of programs that we are concerned with. The first, consisting of complete and tested systems for users, is perhaps the most extensive and the

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Selfridge
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Cont.

most likely to be aided by the EDUCOM network. It is also the one that creates the fewest problems, because such systems are already being tested and run operationally at several centers around the country. The S.D.C. system, Project MAC, and several JOSS-type systems are all currently being operated and tested; it is quite clear that such systems can be provided over a cooperative net.

Another kind of program that is of major interest to EDUCOM is Computer Assisted Instruction. Such programs by their nature require the kind of documentation that makes it easy to share among a network; the network can aid by speedy dissemination and by providing a timely and flexible path for feedback. Questions that cannot be answered by the instructor can be channeled at once to the author.

Computational programs or systems of a less well-known kind, or those whose development is only beginning, are shared very little. Sometimes a program is not shared for a very good reason—it may be proprietary (we object to such things on all kinds of grounds, and I believe there should be no such things ever; but there are and will be); it may be constructed for a very special reason which the programmer can be very sure will never occur anywhere else; or it may contain highly classified information. But usually a programmer benefits from having his program used fairly soon if it has any broad interest at all. With luck, moreover, the user will benefit from being able to give the programmer feedback about the advantages and defects of his program before it is frozen into final design.

We shall be concerned with this latter class primarily: that is, with computer programs whose purpose is computational and with those which are being developed or are in trial use. As we mentioned before, computer programs are used outside of the place where they are developed only after a period of some months and substantial effort at writing.

It ought to be very easy for a computer programmer to broadcast the existence of his program "for experimental use" by using the network to disseminate the information about it. He could call a library service program which would quiz him about the content and working of his program, about its status, and so on. When a user

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Cont.

expressed a need for such a tool, that program would be described if it seemed to satisfy the need. A language for describing programs and the things they do would be needed, but initially a reasonable set of key words or phrases should suffice. We will need some standards about the reliability of programs and some form of testing (other than by the author), if a program is claimed to be reliable.

The mode of network use can vary widely. At one extreme, the author of a program can supply full listings of it, copious documentation about its use, and small instructional programs to test it with. At the other, it is conceivable that he merely supplies a standard format for asking questions about his program through the network.

It is a general principle of computer systems that a program ought to be able to perform any function that a user can. One can imagine, therefore, that a running program can call, through the network, a subroutine that is available on some other machine to which it is linked. The call may not necessarily be evident to the user of the program at all. The standardization of formats for such a capability is not a trivial problem; moreover, attention will have to be paid to the printing of error messages which often occur in the utilization of system programs—there should be a standard option of fielding error returns by the calling programs. Also, any time a program is accessed through the system, that access should, at the author's option, be logged, perhaps including comments from the user about its performance.

Another general systems principle is that, wherever possible, options of use have some standard or default condition. Thus, there should be an option of use, such that error conditions are printed out on the user's console, but that the option is over-ridable by programs or users; but the average user should not even need to be aware that such an option exists. There should be a standard format for the transmission of engineering numbers, presumably floating point; but there should certainly exist options for other formats, like integer, double precision, and so on. We would imagine that the default standard would be floating point.

Our system would need, fundamentally, an on-line library system of programs that would maintain an up-to-date directory of all programs entered; the directory

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Cont.

would be list-structured, containing at least: author, name of program, computer language, reliability, mode of usage (e.g., copyable, executable-only), date, and home machine. Other options would be: a set of keyword descriptors, length, special formats for use, conversion programs to be used, links to other related programs or to other entries in the directory, running time, and so on. It is too bad that there is not in operational use such a library of programs. Perhaps one of the advantages of EDUCOM will be to spur such developments.

The remote use of computers and their resident programs and data bases was discussed from the viewpoint of enriching course content in the engineering schools (other disciplines would doubtless be just as interested).

XXIV
Katz
7/24

It takes a lot of effort to develop good computer programs for solving certain types of problems. Many faculty members have developed such programs for use in their classes or in research. Today, faculty members at the University of Michigan (and elsewhere) are using the programs at Dartmouth via teletype and the telephone lines. A network would allow persons at one school to use the programs at another school when proper arrangements have been made. This application of the EDUCOM network proposes to establish a working interchange arrangement in engineering.

The engineering teachers at the schools on the EDUCOM network would like to know of the availability of programs at the other schools. Instructions for using such programs and a written description of the programs would be needed. The writer proposes to organize interested faculty members on the EDUCOM network for the interchange of programs.

First, this proposal would be circulated to the several schools along with a questionnaire which would need to be filled out for each program offered. Upon receipt of the completed questionnaires, a compilation of the programs available would be returned to the several schools, asking whether there is interest in using them. For those selected for the interchange file, the originator of each program would be asked to prepare the necessary description and instructions for distribution. Input-output equipment needed, time of execution, and cost for

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Katz
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Cont.

use would be ascertained. A method for Professor A at University B to obtain permission to use a program at University C would be established.

Additions and deletions to the list of available programs should occur frequently. An on-line file would be established for all to interrogate. It would be expected that an individual professor would be willing to spend much more effort at developing a good program when there is a potentially large group of users. In a sense, such programs would be considered publications.

Should some problem-oriented programs become available outside the network, effort could be made to bring them to a central storage.

Until the survey of programs has been made, the requirement beyond the usual typewriter input-output device is not known. However, the use of display devices and the light pen would be expected. Many programs of this type should operate on-line in the classroom. Only nominal sized storage would be required for the interchange file, the programs themselves, or their execution.

The interchange would provide course enrichment in that the good ideas of one professor would be used directly by other teachers. The competition of providing good programs for teaching purposes would stimulate a higher level of activity in course improvement. The network is needed for on-line use, and there would be no need to re-establish the programs at separate institutions in order to use them.

In research, new computational services would hasten the work of many investigators and reduce the expense of developing programs on many occasions.

A conservative estimate of the use of interchange programs in engineering is:

First Year Operation Assuming 10 Schools on EDUNET

- Thirty educational programs distributed.
- An average of five teachers using each in three classes per year with twenty students/class.
- Education use equals 30 × 5 × 3 × 20 = 9,000 students.
- Ten research programs distributed—an average of eight research persons using each program ten times per year.
- Research use: 10 × 8 × 10 = 800 calculations.

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It is believed the file of interchange programs would have a net growth of twenty percent per year × number of schools on EDUNET/10.

Extension of this type of service could well come in the form of specialized computing equipment which would be justified because there would be a large number of potential users for a given class of problem.

Such interchange programs need not be limited to a discipline like engineering, but could well be conducted for all schools, and especially for advanced work where each institution has a limited number of students.

Remote use of computers was further discussed from the point of view of making these facilities available to institutions which otherwise could not afford them and reducing duplication of effort.

XXVII Hanson 7/27

The sharing of computer resources will be considered at three separate and distinct levels. They are as follows:

1. Provision of complete computational services including access to standard programming languages and the library of standard programs and service routines,
2. Capability to use remotely exceptional computer programs developed at an institution on that institution's computer system, and the
3. Sharing of unique data files developed and maintained at individual computer installations.

Many smaller institutions do not have campus computer facilities or have systems with limited capabilities. Most smaller institutions can obtain access to remote installations only through the mails or by transporting personnel to the remote facility. Such access is inefficient, wasteful, and extremely frustrating to the user. If these institutions are to meet their present-day educational and research responsibilities, they must have direct access to adequate computational facilities. The availability of a complete computation service on an EDUCOM network would meet this need.

The development of effective computer programs or systems to handle sophisticated tasks is an expensive and time-consuming proposition. Efforts to share such programs between institutions often fail because of

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Hanson
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Cont.

hardware and software incompatibilities between the sharing institutions' computer facilities. This then leads to a duplicate expenditure of resources in extensive reprogramming. A network capability to use remotely exceptional computer programs on the program originator's computer system would avoid these pitfalls and would benefit the entire community of computer users.

Such a service should be restricted to exceptional programs except in the case of "have-not" institutions. The current program library systems established by computer manufacturers and computer user groups adequately provide for the exchange of standard programming packages such as common statistical routines, etc.

The preparation and maintenance of extensive data files for computer processing are other expensive and time-consuming processes. Yet, here again an enormous amount of resources are wasted due to duplication of effort. In this instance, the loss is most often due to a lack of information rather than system incompatibilities, since many ways are now available to transfer data from one computer system to another. The establishment of a network information center on the availability of such data files would prove of great value to all computer users. To date, no extensive, organized effort has been undertaken in this area.

In the beginning, a limited computational service could be provided by tying one of the existing remote computer services into the network. System information could be made available in hard copy, and all users could operate under the accounting procedures established at the service installation. The network would serve as a clearinghouse for system accounts.

Any extension of this service and the implementation of the other levels of service would require close to two years' time to develop a worthwhile level of service. An extensive network information system must be established to provide user information, which must be assembled, evaluated, and introduced into the system. All programs and data files must be brought up to system standards, and an updating and maintenance system must be established to insure that all information is current and usable. Any budget estimates would require an extensive systems study and survey of user requirements.

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Hanson
7/27
Cont.

In these applications, as in many others, the network is critical in reducing the access time to desired service or information to a level that makes the service truly useful. Also, the network provides the necessary central clearinghouse where the current body of organized information on available computer resources can be systematically filed and kept current.

The remote use of a computer with privately supplied programs and data (a prime example would be on-line debugging) was also discussed. Many users may do so only occasionally or may be new to computing, so attention is directed toward the need for documentation of procedures and automatic guidance of the user.

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Grosvenor
Katz
7/25

EDUNET should provide on-line debugging and computation service either through its own computer or via a computer operated by a participant. In the long run, many participants with relatively low computer requirements will desire to join the network. The question to be resolved is whether such users can join the network with only a teletype representing the node or whether they should be connected through a node consisting of a more elaborate time-sharing computer. This application is a variation of the interchange of computer programs. It differs in that participants will generate their programs and therefore require on-line debugging service as well as make computations.

Since the large university members will undoubtedly be self-sufficient in supplying the computational needs of their campus, one typically thinks of this capability within the network as a service for the small school or professional person. However, such terminals have the same problems as remote terminals on time-shared computers at large universities.

The debugging and computing service should recognize the long string of newcomers to the computer—each year a new group of students and new faculty must become acquainted with use of the terminal operation and computer capability. A feature of the operation should be as much self-learning as possible via the computer itself. Man-machine interaction with instructive diagnostics can shorten the time for the new learner to complete

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Grosvenor
Katz
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Cont.

and execute programs. Written manuals of the program language and computer practices are needed. Availability of language processors and instructions for their use should be included, as well as object language library programs.

Manuals should cover:

1. EDUCOM operational procedures (administrative)
2. EDUCOM operation procedures (hardware-software)
3. Facilities
    a. Configuration (complete or selective list)
    b. Language processors (complete or selective list)
    c. Effective charge structure
    d. Methods of getting information on use of programs
    e. Methods of getting terminal information on use of language processors
    f. Program descriptions (limited in length but might be complete)
    g. Source language list
    h. Short write-ups (limited in length by the amount that is practical to transmit via the slowest terminal—longer write-ups, if necessary, would be available from EDUCOM as hard copy).

Monitoring of such remote terminals should be provided by EDUNET, since they would not be expected to have interface facilities. Generally, it would seem that only a limited number of such terminals would be used in the initial period of operation to find out whether direct access to the network is advisable. When considering the personal service normally required by such remote terminals, the attachment of remote devices through a neighborhood time-sharing computer with a competent staff might be preferable.

Computer Assisted Instruction

XIV
Zinn
7/23

Typically, self-instructional materials have not received wide use. Very large investments in preparation of such materials have been spread over only a few students of the original author and perhaps some close colleagues. Part of the problem may be in the difficulty of adapting programmed and computer assisted instruction for use by students other than those for whom they were originally prepared.

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Zinn
7/23
Cont.

Computer assistance offers partial solutions through on-line data banks of materials in preparation, working files for cooperative preparation efforts, less expensive telephone conferences among joint authors, automated text editing, and opportunities to try materials on students at other institutions.

XI
Ramage
7/14

Investigations of computer-aided learning indicate that instructional programs having a significant level of individualization in the decision processes used to present information to a student and in the analytic processes used to interpret a response from a student require large amounts of computer capacity. It is unlikely that each location desiring such instructional capability will have the resources to operate a self-contained installation. However, the operation of a satellite terminal or computer which is connected via a communications network to a large installation can provide much of the capability of the large installation at the satellite location at less cost.

The development of computer based instructional programs is an extensive and time-consuming operation, and to obtain a sufficient library of programs, the efforts of many institutions will have to be involved with each institution contributing efforts in those areas of its particular expertise. This consolidation of effort to create a common library of programs which can be communicated over the connecting network to any satellite location is further justification of the concept of one large installation serving many satellite locations.

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The network is particularly important because of the community effort involved and the need for facilities which would not otherwise be available on individual campuses.

XXVIII
Summary
7/26

CAI has the following characteristics:

1. To work in it experimentally requires a substantial capital investment in both hardware and software;

2. It has a number of dimensions (programmed learning, aids in problem solving, graphical manipulation, simulation), which are different enough that even leading workers will not have experience in all phases;

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Summary
7/26
Cont.

3. The related software includes programming or manipulatory languages of special sorts, including relatively complex procedures of system use;

4. General incompatability of terminals and computer configurations makes it prohibitively difficult for an interested group to learn about this application by trying it on their own computers;

5. Nevertheless, there is good reason why a variety of academic groups would benefit from being able to learn about and monitor developments in leading CAI research groups so as to evaluate progress and contrast technique without making any large investment of resources.

To provide a single EDUCOM interface to a number of participant systems having, in general, a variety of terminal codes, terminal types, and operational procedures, it would be necessary that EDUCOM (or some participant of it) have a computer with a suitable program, including a monitor for time sharing and a service program for translating terminal codes and transmitting the translated requests. With a bit more elaboration such a program could accept an EDUCOM standard request and forward a suitably formatted request to the participant system. The operation of such a system is apparently inevitable in EDUCOM, since it is the prototype "executive computer" of the network. Thus, it does not seem a bad idea to think of this as a relatively small and easy starting function for the EDUCOM executive network to concern itself with while building up a much larger and more complex capability.

An experiment was suggested with instructional materials made available for development and testing via a network.

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Zinn
7/23

The primary network users in this application are authors and scholars (university professors), and the secondary, the students on whom the materials are tested. In this pilot project students will use the network only for the purpose of testing the materials; students will not receive regular instruction by the network facilities apart from the requirement of the study.

Materials will be selected to represent different subject areas: statistics, physics, psychology and German reading. Authors are already preparing materials on these topics at SUNY Stoney Brook, University of

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Zinn
7/23
Cont.

Pittsburgh, University of Michigan, University of California, San Francisco, and Systems Development Corporation.

The network is expected to store and be able to process a file of up to 1000 pages of text and computer instructions. The organization will be primarily serial and may be segmented so that not all of it need be kept available for access at all times. The materials will be updated as frequently as every day, and every project member is to have access to all materials. Others not associated with the project should be protected from mistaking the rough drafts for finished products; any author may choose to exclude nonproject members from access.

During drafting of materials participating authors will enter evaluative comment into working files in computer memory for consideration by others on the project. During trial use many aspects of student performance and attitude will be accumulated in similar files for data reduction and analysis. The success of the project will be measured by the amount, quality, relevance, and applicability of materials produced. In fact, it would be successful if it only identified problems in interinstitutional activity and suggested means for their solution.

The study is intended to identify and describe problems and procedures of network operations on a small scale, list the requirements and unmet needs, and demonstrate the importance of immediate access to CAI facilities at remote locations.

The network is already successful to the extent to which community communications and processing can be credited for facilitating the efforts of the participants. Some relevant data are delays or interruptions in service, inaccuracies in transmission, misinterpretation of procedures, etc.

The development of CAI in an individual institution and the desirability of a network for its further exploitation was described:

X
Kearns
7/14

The Social Sciences Division of the University of California at Irvine is now developing computer assisted instruction (CAI) material. This material will be used to supplement or replace units of introductory courses of

X
Kearns
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Cont.

the Division beginning in the fall quarter of 1966-67 year. By June of 1967, the various academic disciplines within the Social Sciences at the University of California at Irvine—psychology, political science, economics, and sociology—will have a year's experience in using CAI in their courses.

There are distinct advantages in extending the development and initial use of this material to include a number of universities and their faculty members. The way this could be done with the conditions appropriate for meaningful research and experimentation would be via a network.

The development of CAI as a pedagogical technique in the social sciences depends, in part, on its experimental use under controlled conditions involving a number of students with a variety of backgrounds and preparation. The network provides not only access to the student but also the controlled conditions.

The development of CAI material of any note is a sizeable undertaking but one that can be handled by the involvement of a number of faculty, each concerned with only a portion of the total material. The necessary support in the way of systems and experienced personnel is not available at every institution but could be mustered at certain institutions to serve the others involved via a network.

In the process of producing CAI materials, there must be constant changes which include refinements, corrections, and deletions. For these changes to be effective it is necessary to have the capability of entering them into the system on a real-time basis. For example, a change entered by a professor at one institution would be immediately effective in the material presented to students at many institutions. The network as visualized here provides this capability.

On this basis, it is suggested that one of the academic disciplines of the social sciences, e.g., political science, be chosen as a medium for an experimental CAI network. Members of the faculties of the participating network institutions in the selected discipline would take part in the development of units in a course to be selected and would participate in the experiment by having their students in this course take instruction on terminals via the network.

X
Kearns
7/14
Cont.

> One of the network institutions would act as a hub of the activity, meaning that the instructional material would reside in its files, that it would be responsible for collecting statistics on the students and their responses for evaluation purposes, and that it would provide the mechanisms to modify and add to the instructional material through the network on a current basis.
>
> Assistance in implementing this activity could be sought from interested professional organizations such as the Council of Social Science Data Archives.

All suggestions at the Summer Study for CAI use of a network were clearly experimental. No one proposed that massive operational instruction be carried out over very long distances. Instead it was recognized that as instructional units become available, and, assuming that the network experimentation is as successful as anticipated, local or regional "hubs" of instructional networks would become desirable. The geographic area and the size of the student body that could be covered would be dictated by the economics of the situation.

Planning for experimental instructional networks is currently being carried forward. The first such experiments making use of existing facilities should be active within a year.

Computer Assisted Menu Planning (CAMP)

The need for a national network for menu planning is at first rather surprising. Yet, this application is of considerable interest because it may be illustrative of a use of a communications network that has not been clearly stated elsewhere.

In operation, CAMP is likely to make use of regional or local networks; why then should it be of interest at this time to EDUCOM? The answer is that computer assisted menu planning is a tool, making use of sophisticated mathematical methods and directed toward a group of users who are unaware of the power of these methods and distrustful of them. Simply, its use needs to be demonstrated and taught.

X
Balintfy
7/18

> The interdisciplinary gap between the customarily subjective, sometimes dogmatic, and admittedly flexible professional standards and the rapid scientific interpretation of menu planning is considerably wide. The rapid advances in management science and computer technology find the majority of the schools of nutrition, dietetics, hospital, hotel, and food service management unprepared and therefore slow or unable to respond to the challenge of progress in this direction. There are no signs from within the existing educational machinery of this field to indicate that significant help in understanding and using linear programming models will be given to thousands of mathematically untrained people—who are nevertheless obliged to carry on planning menus for millions of others—in the foreseeable future.

The principal reason that CAMP should be widely disseminated through a network is in its potentially large economic consequences. If realized, the estimated savings in widespread use of this tool could go a long way toward paying for EDUNET.

X
Balintfy
7/18

> The need for efficiency in performing the necessary reeducational program finds its justification in the unusually high and far-ranging social payoff of the induced technological change. The most important and general effects of computerized menu planning are the decrease of the cost and of the simultaneous increase of the quality of food service. These effects follow from the proven superiority of the mathematical optimization process and electronic data processing over human decisions based on incomplete information. The first pilot studies completed by the author and by other independent sources indicated food cost savings from eight to thirty percent, depending upon the formulation of the institutional objectives. Additional experiments and the actual implementation and current operational evaluation of computer assisted menu planning at the Sara Mayo Hospital in New Orleans show about twenty-four percent cost saving. This latest evaluation also provides evidence

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Balintfy
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Cont.

that about seventy percent of the saving was due to the linear programming techniques while the rest of it was realized through the higher accuracy in data manipulation.

Although the above information was derived from hospital-related studies, the economic conclusions are presumably valid for many other forms of institutional feeding too, because of the similarities in the decision problems and in the methodology of solution. These include the school lunch program, which feeds more than half of the forty-five million school children a meal per day; the college food service system, feeding over six million college students plus parts of the staff; the food service organizations of the armed services; and the feeding programs of various detention homes and nursing homes. It seems that on the basis of the numbers involved, educational institutions have the highest stake in realizing the potentials of saving cost, improving food service, and promoting nutritional health by computerized menu planning. Many of these institutions also have the computer facilities to do the job.

As far as the hospital applications are concerned, the expected impact of on-line computer assistance in the dietary departments is of major significance. In addition to the possibility of saving one to two percent of the cost of hospitalization for more than a million patients, the prerequisites and side effects of menu planning in the organization of dietary information processing also offer inestimable services. It will be the first time that exact data will be automatically available for both dietary decisions and for clinical records in hospitals. Since these data must include a variety of nondietary information (such as statistical and accounting data) in an organized form, a plausible argument can be made that computer-assisted menu planning is the natural first step toward automated hospital information systems.

Summarizing the present state of institutional menu planning, we arrive at the following conclusions. If optimal results are to be achieved, menu planning must be seen as a very difficult, complex, decision problem, solvable only with the assistance of computers and computer codes based on advanced mathematics. The acceptance and intelligent use of computers for menu planning require a large scale educational process; but the new

Table 4-3. Possible Implementation Schedule for Nonschedulable, Interactive Applications

Application	Implementation	Remarks
Directory of On-going research	1968	An earlier start is possible for a limited directory.
Directory of Information network data	1967	Can be started even before a network and computer files are available.
Directory of Network-related activities Directory of Learning Aids in the Health Sciences Location of Experts	1967	Data can be collected, placed in machine-readable form, and used in a manual directory as soon as formats can be agreed on and the necessary committees and staff groups established.
Toxicological Information Network	1968	Full scale operation may not be possible until 1969.
Health Services Information Network	1970	An outgrowth of Toxicology Network.
Major Bibliographic Services	1969 and later	Some of these services might be possible earlier if limited in scope or if already computer based but the larger undertakings in this area will take time.

Table 4-3—Continued

Application	Implementation	Remarks
Dissemination of Computer Programs	1968	Requires feasibility study of network unless operated manually as is done now.
Remote Use of Computers	1968	Early start possible by use of existing time-shared computers.
On-line Debugging	1969	Needs time for documentation and development of software beyond what is now in use.
Computer Assisted Instruction	1967-68	Feasibility can be demonstrated and problems studied with crude and even temporary networks. More extended development comes later.
Computer Assisted Menu Planning	1968	Requires an operating network to demonstrate feasibility.

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Balintfy
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Cont.

technology is expected to produce cost savings and other educational, social, and health benefits in an unprecedently high order of magnitude. CAMP is recognized as the only available and practical approach to training people in the use of menu planning models. The EDUCOM network offers a unique opportunity and is the perfect choice for making CAMP accessible to the largest number of institutions in the shortest possible time.

One wonders what other applications of similar potential could use the national educational and dissemination capability of EDUNET.

VI. INTERACTIVE SCHEDULED APPLICATIONS

Uses have been proposed of networks which presuppose a high degree of interaction on the part of the users and which should also be scheduled. The scheduling requirement arises, in part, because the people using these network applications have a schedule and also because such applications would make heavy use of either the processing or channel capacity of the network. For such applications it may not seem reasonable to pay the price for the capacity required for unscheduled use so, instead, the price of scheduling must be paid.

Applications discussed in the Summer Study that fit this category were live television conferences, classes, seminars, and professional meetings. We should note that, although such network uses are heavily dependent on television, they are also related to other network applications that have been discussed earlier.

Suppose, for example, a seismic data acquisition system and alerting network were established and were activated by a disturbance. Seismologists could quickly establish a television conference to study the cause of the disturbance, the extent of damage, and the probability of continuing disturbances.

Information that should be available to this conference would include current measurements from seismic stations, recent geological data concerning the affected area, a history of other disturbances showing similar characteristics, and perhaps a mathematical model of the geological structure of the area. In other words, the conference needs access to the data bases and processing capacity of EDUNET in addition to using the network as a conference medium.

II
Licklider
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Because the next term on the list is jargon, I have put it in quotation marks. "Teleconferencing" is interaction among geographically separated people as though they were together at a conference. EDUNET will be able to bring its members functionally together. With the aid of devices mentioned in connection with remote teaching plus such techniques, not mentioned in that connection, as stereophonic coupling of distant conference rooms (described in a Working Paper by Robert Wallace of the Bell Telephone Laboratories), EDUNET could create a realistic simulation of face-to-face meeting. More important than that, in my opinion, is the fact that, with the aid of its on-line computers, EDUNET could introduce a dimension not ordinarily available in face-to-face conferences. It could provide on-line information retrieval and processing—for example, retrieval and reduction of data from on-line data bases and dynamic display of models retrieved from files of models maintained within the network.

Instead of proposing a project in the field of teleconferencing, I shall simply report briefly on a conversation with Joshua Lederberg, who is interested in developing this technique. Suppose, to take his example, that a number of scientists meet in Washington to discuss possibilities and plans for remotely controlled exploration of the surface of Mars. They discuss many scientific and technical facets of the problem, agree on some things, disagree on others, and go back to their respective laboratories with unresolved questions on their minds. Following the currently prevailing pattern of communication, some of them encounter others at meetings, there are several telephone discussions, and

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each man further develops his own ideas and thinks of flaws in his colleagues' schemes. Then there is—after a month or so—another committee meeting in Washington.

For one thing, Professor Lederberg does not like to travel; he is interested in cutting down the number of meetings that he has to attend in Washington. Perhaps more fundamentally, he is concerned that the thinking and planning that goes on between meetings is less effective than it should be. Should it not be possible for subsets of the committee, groups of two or three scientists interested in a particular facet of the overall problem, to interact through telecommunication channels? Should it not be possible for them, in such interaction, to take advantage of computer-processable data bases, computer-program models, and packages of computer programs designed to facilitate the kinds of calculations involved in the planning of space exploration? It seems to me that Professor Lederberg's ideas define a framework for an interesting project. The project should have a definite focus of concern. That focus should be important enough to make it worthwhile to provide the hardware and software facilities for interaction. The people involved in the interaction should be primarily interested in getting their work done, and they should be sufficiently prestigeful that their assessments of the effectiveness of teleconferencing would carry weight.

In the medical area the need for continuing education has been cited repeatedly. Interactive television conferences are proposed as an effective means of making continuing education available, practical, and effective for physicians.

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One of the primary methods by which a physician enhances his knowledge and skill in the art of diagnosis and treatment is the observation of how an exceptionally skilled clinician practices that art. The method is exemplified by grand rounds, ward rounds, clinical pathology conferences, and similar techniques.

Continuing education should make it possible for the practicing physician to observe, and participate in, such conferences without having physically to remove himself from his community and his practice to the locale of the conference. Appropriate application of modern technology should make it possible for him to observe and

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participate in such conferences by use of a network terminal at his community hospital and ultimately at his desk in his office. Audio-video transmission, with audio response, are minimal network capability requirements.

Participation and observation call for a network linking the physician, through a terminal at the community hospital or county medical society and ultimately his office, with a center of clinical excellence. Presumably, such centers of clinical excellence in most instances would be university medical centers and affiliated hospitals in a metropolitan center. The network should link such a center with a considerable number of communities in which physicians practice. Although reference is made to the practicing physician, there is need for continuing education of other health professionals as well; and it is presumed that universities have a heavy responsibility also in this sphere. The network proposed would be useful in the continuing education of practicing physicians, nurses, technologists, dieticians, in fact, all the paramedical professions. The suggested initial location of community terminals in community hospitals stems both from practical considerations of terminal cost and accessibility and from an awareness of the multi-discipline teaching for which the network would be used. The network should be broad band, having minimum capability of one-way audio-video transmission, with an audio return link from receiving terminals.

A key and essential feature is the provision for participation, as well as observation, by the physician at the receiving video terminal. This privilege of the viewing physician to ask questions, seek clarification, interject comments, and pose challenges is considered so essential as to warrant the live production of such conferences.

The group feels strongly that programs of continuing education for the practicing health professionals must be substantially user-oriented. Participation via audio linkage in a live telecast conference is a very effective device to insure user-oriented content.

A word about what we mean by "user-oriented" is in order. Fundamentally, participation by the practicing professional in continuing education is a voluntary action on his part, in contrast, perhaps, to the captive audience represented by the registered undergraduate and graduate student body of the university. A prime goal of

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continuing education is to elicit the voluntary participation of the practitioner in the learning process and through this participation to raise his level of professional competence. The desired and expected result is the accelerated application in practice of newly developed knowledge and skills resulting in an improved level of the nation's health. Because the practitioner participation in the learning process is voluntary, continuing education programs must: (a) meet the practitioner's needs as he sees them, i.e., be user-oriented (albeit continuing education may well have an obligation subtly to sharpen or alter the practitioner's concept of his needs); (b) be readily accessible to him; (c) be substantially problem-oriented; (d) provide information usable by him within the parameters of his working environment.

There remains, of course, a significant role for prepared-in-advance programs, such as film or videotape, provided they are user-oriented in subject matter and presentation. Such films or videotapes may be transmitted via the network or distributed by other means for local projection.

Among the many possible permutations of the above are: grand rounds; demonstrations of new techniques; instruction in use of new equipment; exposition of the value, availability, reliability, and normal ranges of diagnostic tests provided by community hospitals, regional laboratories, or medical centers; interpretive significance of clinical pathology findings, X rays, EKGs; expositions on the optimum utilization by the practicing physician, dentist, et al, of the skills of paramedical personnel; etc.

A number of other educational activities have been noted where imaginative use of closed circuit television networks could be made.

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Each school has a limited number of leaders in the various facets of the engineering sciences. Doctorate students in engineering need seminars wherein they have the opportunity of exploring advanced topics in several fields. Usually such seminars require independent papers by the participants. The usual seminar is given by staff members active in research, but such research usually is in a rather narrow band as compared with the desired scope of the seminar. It is proposed that the combined staffs of EDUCOM schools could give network

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seminars in which research people active at the frontiers of knowledge in a wide spectrum of any subject would participate.

An on-line, face-to-face communication system is needed to conduct the seminars—closed circuit television with from five to eight groups participating. The professors in the various schools could take turns in organizing the seminars. The approach suggested is that one or two topics be handled each year and repeated only at four to six year intervals. Topics which appear suitable now are:

Thermodynamics
Fluid Mechanics
Plasmas
Solid State Science
Rate Processes
Separation Processes
Systems Analysis and Design
Energy Conversion

The occasion for the seminars would become a renewal of interest and coverage in the treatment of the subject at all levels. The seminars could cover not only the latest research topics for digestion by the graduate students but also the upgrading of courses taught by the staff.

One aspect of such a project would be the preparation of a bibliography on recent literature, reports, papers in press, and doctorate theses under way in the field. Such information would be organized into a network data file and available for interrogation by students and faculty. Such access would normally be via computer consoles with typewriter I/O. Students completing their papers would make presentations toward the end of terms or the year, and they would have the experience of appearing before a wide audience while working with an information system.

It is possible that certain seminar presentations would be stored on videotape for use by others or for repeated display on the network on demand.

The program would consist, in summary, of: (1) organizing the seminar presentations and topics for student study, (2) organizing and updating an information file on current work (not limited to the open literature), and (3) establishing a videotape library for use by others or for repeated performance on the network.

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The above statement shows that three network activities are planned: (1) on-line TV intercommunicating among several groups; (2) establishing a data bank or references with interrogation and updating permitted on line continuously; and (3) video recording, storing, and retrieving on demand.

A network seminar would upgrade the level of instruction to a high degree. The excellence in capability at one school could be shared by all participating schools. The doctorate students would have superior training. Staff members would have a format and basis for revising their course instruction in the topical area of the seminar. Workers in a given field would become well acquainted with their counterparts at sister institutions. Much time would be saved by joint preparation of the reference file, and the students and staff would have the advantage of quick reference. Both the teacher and student should reach new heights of excellence in exploring the frontiers of knowledge.

It is obvious that this pattern could be used for most disciplines at a university. Once the TV facilities were established, they would soon find many hours of use per week.

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If each ground station had the capability of receiving or transmitting several programs at the same time, this system could be used for two-way video and radio connections which would make possible competitive engagements, such as debates between educational institutions; and, obviously, such debates could be monitored by many other institutions.

In the area of continuing education, which is very often involved with studies in the social sciences, not to mention continuing medical education and continuing education for other professional schools, the capability suggested above would make available the services of outstanding speakers and resource persons and would provide for an optimal interchange of information. For example, a university on the west coast which is holding a seminar or conference on "Small Business Management" might utilize as a resource person a professor from the Harvard Business School who is nationally recognized as one of the top men in the field. Or, it might

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be possible to bring together by television, several authorities in other specialized fields such as nuclear engineering, medicine, and the humanities for the benefit of a symposium of scientists meeting at any university.

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Many schools are removed from the centers of population or normal travel paths. Journalism students need experiences in interviewing persons whose views are of significance. Closed circuit audio-video would permit classes to interview important personages elsewhere.

Closed circuit television facilities would be established at centers of travel, and they would be on the network. When leading personalities are known to be available at such centers, arrangements could be made for them to go on the network. The classes could see the personage interviewed, and the student asking the questions would be seen by the interviewee. A master of ceremonies would be needed at the site of the interview to manage the questioning among the groups on the network. He might function better if he could receive the typed questions proposed by individuals from several groups involved.

The following requirements are desired:

1. Two-way audio-video—one way from interview site to several sites on network continuously and one way from individual site to interview site, with switching between initiating sites.
2. Voice between individual sites so all can hear questions asked.
3. Message communication from individual sites to interview site.

The establishing of closed circuit audio-video facilities in a suitable room at the schools and for likely interview sites would be the primary job to permit this activity. Since several organizations are likely to be on the network at travel centers, i.e., New York, Chicago, Washington, D. C., San Francisco, Los Angeles, etc.; no unusual facilities would be needed beyond those useful for seminars or conferences.

and finally of particular significance to EDUCOM

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Seminars are needed to teach faculty and research personnel generally and to provide specific information on how to build information files. These seminars could well be conducted over the network.

Many research people could make profitable use of small information or data files. Such files would improve the efficiency of the researcher and would make his work more meaningful. To get faculty and research workers to establish such a file requires some encouragement and knowledge not available to them. There is a parallel in this case to that of a few years ago when it was necessary to encourage faculty members to use computers in the educational process.

Today, most people keep a card file of pertinent literature or rely on theses and papers as cross references.

A person knowledgeable in preparing information data files should be encouraged to enlist two to five people on the network who have like interests and abilities. This group of persons should develop a short course on information file preparation. This course would describe the ideal type of file, demonstrate the use of files already on the network, and set forth the procedures which an individual should follow to establish a file either for himself or for a specialized group. As part of the project, a small file of material on bibliographical files and their uses could be established to demonstrate the construction process.

Once the material was organized, the course would be given via the network with the presentations to be made by several members of the group residing at different locations. Written text similar to Organick's FORTRAN primer could be prepared as well. The course might be repeated twice a year for two or three years so that persons beyond the graduate student stage could acquire knowledge concerning this new technology.

It is presumed that the project would be established by mail communication. The network would be used:

1. To conduct the short course simultaneously at several institutions preferably by closed circuit audio-video,
2. To demonstrate the use of a data file on the network,
3. To prepare audio-video tapes of the short course and arrange for showing them on demand.

The continuing education of scientists and professionals in all fields might benefit from imaginative use of television in professional society meetings.

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Professional societies, in a certain sense, constitute a method of communication between universities and between universities and the practitioners within a given discipline. It is natural, therefore, to consider the question of the benefits that would accrue to this operation with the availability of improved electronic networks.

One of the many activities of the professional societies is the local meeting where the program usually consists of a talk or discussion on some topic of current interest to the members. Speakers are often of national stature and would attract interest from a much wider audience than the local chapter if improved means of attending such meetings were available. The existence of a video network would permit the program to be broadcast to several areas; and the speaker could, in fact, constitute the program for several local chapters at the same time.

The network that provides such coverage could have several levels of interaction capability. In the simplest case the network is equivalent to a closed circuit television channel, and the program is simply broadcast to the locations desiring it. The next higher level would provide the capability of allowing each local area to participate in the discussion or question session of the meeting by transmitting over teletype or suitable facilities comments or questions which are printed at the speaker's location so that he may respond to them in turn as time permits. A higher level of interaction would make use of switchable, duplex television channels so that each local area having comments or questions could be switched on to the broadcast channel and form a composite picture with the speaker or acquire the entire picture for some interval of time.

This last technique provides the speaker with interaction with a much larger audience than could be obtained even in large auditoriums and may have to be limited so that the magnitude of the audience response does not become unmanageable. A live presentation with audience participation has sufficient motivational appeal over taped presentations that it is believed that this technique

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would be worth running several times with the same program in order to cover the interested audience and to allow for time differences in the various parts of the country.

In a function similar to the above, a high capability network could augment the national and international conventions of the professional societies. Papers being delivered could be broadcast in the same manner as with the local meetings, and for those conventions that run multiple sessions the use of multiple channels or band compression techniques would provide greater facility of selection and coverage to a viewing station than that available to an individual in physical attendance. Responses and questions from remote locations could be accommodated in limited numbers.

One of the popular methods of discussion at conventions makes use of a panel of experts who briefly introduce a current topic and then respond to comments and questions from the audience and other panel members. The use of a high capability network would allow participation by panel members who are at physically different locations. A composite picture including each panel member could be broadcast and the audience could participate by directing their responses to the location of the panel member concerned. This technique could have the effect of making more individuals of recognized authority in a given field available as panel members.

Table 4-4. Possible Implementation Schedule for Interactive Television

Application	Implementation	Comments
Interactive TV	1970 (or later)	Of course, live interactive conferences can be held today when warranted. However, such presentations are likely to be rare until a large number of low-cost TV channels become available.

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Organizational Considerations

I. CHAPTER SUMMARY

Whereas the two preceding chapters have considered many of the recognized needs that might be at least partially satisfied by the availability of an information network and, in more detail, a variety of possible applications of such a network, this chapter looks at the other side of the coin. It delves into the organizational problems that must be solved if an information network is to be established. These problems include not only the internal organization of the network operation in terms of the functions it is expected to perform, but also its relationships to EDUCOM member institutions and to non-EDUCOM institutions; the negotiations that must take place to acquire resources and to enter into service agreements; and the implications of such negotiations on finance, accounting, assurance of privacy, assurance of compensation to originators of materials; questions of priority and system control; as well as the question of how to evaluate the effect of the network on instruction and research.

Many of the questions considered in this chapter were not resolved during the Summer Study. To give reasonable representation to the various points of view and simultaneously to impart some of the flavor of the discussions carried on during the study, we continue to rely heavily on quotations from the working papers. At times the quotations reinforce each other, at other times they are in disagreement, and at still other times they offer similar conclusions or recommendations but from differing viewpoints.

We begin by investigating the structure of EDUNET on the basis of the responsibilities and functions that it may be called on to assume. The discussion reinforces the obvious point that the kind of relationship between EDUCOM and a member university being served by EDUNET is critical to the implementation of the network. The next section of the chapter analyzes the structure of this relationship and highlights the fact that successful coordination will depend largely on the individuals from both the institution and from EDUCOM who provide the liaison. These individuals will need to have stature, technical orientation, and an interest in and appreciation of the problems of others. It is suggested that EDUCOM generate training programs for the liaison people needed. Finally, there is a discussion of the problems involving relationships between computer centers and libraries at the institutions served.

Next, the need for negotiations and interaction with non-EDUCOM institutions—governmental agencies, industrial groups, professional societies, foundations, etc.—is studied. It is clear that problems arising from such a multitude of interrelationships can be resolved only by negotiation with each group. During the study we were able only to cite examples of organizations with which relations must be established.

Section V of this chapter is devoted to the intricate problems of financing, accounting, providing for privacy, priorities, control, and evaluation of EDUNET both in its formative prototype stage and in its later operational stage. We cannot report that a concensus was reached on how to solve these problems. Some participants urged the following principles:

> A consumer of service should make commensurate payments or contributions (no agreement was reached on how to measure the value of services or contributions);
>
> An originator of materials should be suitably compensated (as by royalties).

Others urged that special consideration should be given to institutions and individuals who could be classified as "have-nots." Among other differences of opinion were those concerned with the privacy of files. Some urged that files not be permitted within the network unless they would be available to all (with due compensation). Others noted that situations do arise in which information may not properly be made available to everyone who can pay the cost. Examples of such information would be certain medical data, unfinished collaborative material, and not yet validated computer programs.

The final section of the chapter reviews the roles that EDUCOM must assume to make EDUNET operational and effective. In addition to the ordinary operation of the network, some of these roles are: promotion, instruction, technical consultation, setting of standards, design, research and development in hardware, software, and communications, development of new applications, and coordination with other networks. As the extensiveness of the minimum role of EDUCOM becomes apparent, it is tempting to add more and more responsibilities, each of which is desirable to some context but which together imply that the responsibilities of EDUCOM could become all-embracing. Since it seems unlikely that a new organization can engage in so many activities at once, it may be appropriate to limit the EDUCOM responsibility in many areas to that of cooperation and stimulation.

II. NETWORK FUNCTIONS

EDUCOM's roles in the organization and operation of an interinstitutional information network and in the support functions incidental to the network will necessarily entail relationships with the university and with many segments of society outside the university according to the various contexts in which the proposed network may be viewed.

The essential role of the EDUCOM organization and its relationships with other organizations should be largely derivable from the assumption of a central kernel network with certain general properties.

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> EDUCOM should think in terms, not of a definite, designed, blueprintable network, but of a network of networks, facilities, organizational interrelations, information resources, human resources, services, and projects. The overall network should have one part that is relatively well planned and defined, a part that can be dealt with readily in a proposal, for example, but also other parts that are not planned or defined in detail but treated in a more general way by setting forth avenues and guidelines for formal and informal interactions involving two or more participating organizations.
>
> EDUCOM cannot construct a useful network simply by trying to meld existing networks. It can, however, foster coherence by developing and operating a central registry or directory of networks and related resources.

A basic concept of function and structure of the kernel network was described.

The initial purpose of the EDUCOM system will be to serve as a metasystem for information interconnection of various universities with one another.

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The actions of the EDUCOM system may include the following:

1. Attempts to answer questions about the presence or absence of certain types of information within the files catalogued by the EDUCOM system. Such information might include:
    a. Documents in libraries, actual or on microfilm;
    b. Reviews of documents available in review files (e.g., Chemical Abstracts, Mathematical Reviews);
    c. Names of organizations or personnel with particular capabilities in certain disciplines or combinations of disciplines, developed from the preceding file and others;
    d. Programs in computer center libraries with certifications of their previous performance and information about costs of their usage;
    e. Data banks in computer centers or other automated files with certifications of their previous usage and information about immediate or alternatively batched availability and cost of usage.
2. Actions that might be performed as the result of the above types of questions:
    a. Requests for copies of documents with the request entered automatically into the library interchange system. Appropriate feedback would be generated upon completion of the retrieval and mailing of a copy of a document. (At a later stage in development, a copy could be sent by facsimile to the calling university.)
    b. Performance of a computer program remotely at University B upon the request of a person at University A.
    c. Automatic planning of audio conference calls (at a later stage video conferences) by the system. Personnel at University A would request a conference suggesting alternative times. The system would then serve as broker to arrive at a commonly agreed upon time and so inform the participants.

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- d. Immediate on-time, or later, retrieval of information from "open" data-banks available to all users but located in the local automatic systems of the university or consortium members.
- e. The development of common automatically linked processing systems for use by geographically distant workers in a common discipline (for example, toxicology, nuclear physics, organic chemistry, clinical medicine, mathematics, engineering) that would allow the creation of growing subsystems of automatic files, automatic algorithms (computer programs), automatic retrieval systems, etc., for that particular subsystem. The development of the facilities for such geographically distributed disciplinary structures provides one of the real opportunities for the EDUCOM system.
- f. Sending of a video tape or film by University B to University A upon request through the EDUCOM system.

Structure of the EDUCOM system. The nodes of the EDUCOM system would probably be communication centers, with files located at points, most convenient for EDUCOM members in terms of communications cost. These communications centers would contain on-line, real-time digital computers, used as communications switching devices and file searching devices. These would be large data banks, containing catalogs of information held in member files (either automatically accessible or accessible through human intervention).

Software computer systems should be available that would

1. in case of requests for information:
    - a. accept on-line messages sent from individual member installations;
    - b. search the data bank catalogs for information when requested or pass a request on to an appropriate member for an answer;
    - c. return the information, properly screened, to the individual member line.
2. in case of requests for action:
    - a. accept on-line messages sent from individual member installations;

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b. route the message to another EDUCOM node for local delivery to the receiver;
c. set up appropriate feed-back control mechanisms so that if an answer was not received, both the sender and receiver would be "jogged."

In either case, automatic billing and accounting would be performed, with appropriate additions to standard reports.

The difference between a local EDUCOM node and a university computing center should again be emphasized so that questions of status, prestige, and control may be minimized. Since the EDUCOM system will be a service system, the presence of a "node" on a particular campus or locale should not be a prestige item. The availability of the EDUCOM services, however, should become a highly important item in the status of a university.

The number and location of EDUCOM nodes, therefore, should be based on technical considerations including:

1. The present and possibly future members,
2. The switching needs of the system,
3. The communications costs of the system,
4. The data bank requirements of the system;

plus the consideration of the availability of effective personnel near the node site arrived at in technical considerations. These would be in the neighborhood of large cities or at the universities themselves.

An argument might be made that over the long range, incorporation of EDUCOM facilities with local facilities might be the best method of operation. However, the initial status of proximity to, but not possession by, a university, would appear to be politically more effective. It would also shield the EDUCOM system from local politics within the university itself.

If the EDUCOM system is to transmit the requests and to perform the actions described above, it will require staffs in both the central system planning center and the local centers which have had experience in the development of communications systems. At the same time, such staffs must know and recognize the nature of the American university and what is and is not possible in dealing with the assorted university communities.

There appear to be four distinct types of jobs that the EDUCOM system must carry out:

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1. Cataloging the information on file in the various member universities and setting up an automatically retrievable machine-stored file of such information. By "information" is meant: linguistic descriptions of documents, research tools, personnel capabilities, data files, algorithms, teaching tools, etc. It will be the EDUCOM system's task to define and standardize a language and format for cataloging such information and a system for searching such a catalog. It will be the members' responsibility to provide the catalog, in machine readable and searchable form, to the EDUCOM system. Whether these catalogs shall be stored within the local EDUCOM centers or left under university control is a matter of system design. EDUCOM must provide a standardized way of receiving automatically information for updating its own files. The member must provide day-by-day information on changes in its informational structure.

2. Acting as a broker of services between various universities, including transmissions of requests for information, description of films, video tapes, documents, available computer programs, or data banks and for services (transmission by ordinary carrier of document copies or transmission by the EDUCOM system network of symbolic, facsimile, or video copies). The EDUCOM system must therefore also act as a central billing agency for these services from one organization to another. This business function of EDUCOM is important, and will require the presence of persons knowledgable about present university business procedures.

3. Acting as an automated communications system between the various individuals at the universities through computer consoles, video displays, telephone connections, mail, and express. Therefore, a portion of the EDUCOM effort must be oriented toward construction of standard linguistics and communication structures (in general, languages) that will allow satisfactory interplay between humans, the various catalogs, and the various automatic portions of the system.

It would appear that it should be an EDUCOM responsibility to standardize on-line communications up to the interface with the members, and that the members should have the responsibility of meeting these standards through acceptance of them or through local translators into alternative local systems. Local files within

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member organizations need not conform to a standard, but the local organization must be able to accept EDUCOM standard queries, and the local files should be able to respond in a fashion functionally equivalent to EDUCOM standards.

4. Acting as a creater of "special-purpose disciplinary systems" with common files, common data banks, and common automatic algorithms that do not at present even exist. In this manner, researchers at various institutions would be able, through the EDUCOM system, to create interdisciplinary automated communications structures, to which EDUCOM would provide the already existing services (computer programs, file structures, languages, and transmission equipment) and at the same time would be able to incorporate completed results into the overall catalog files. The toxicology system for poison control, often described, is one example of such a function.

Special responsibilities of the EDUCOM system. Because of its nature as a repository for information on the nation's research structure, the EDUCOM system would probably be called on to perform certain special functions beyond that of central metasystem "broker" and communicator between the universities.

It could immediately serve as an agency to disseminate the results of research activities. For example:

1. A national toxicological network, in which local EDUCOM operating centers make tie-ins to the network available, could be a significant service.

2. The proposed automatic chemical documentation system might be a second candidate for inclusion in such a network.

3. The review systems of scientific communities, exemplified by Mathematical Reviews and Computing Reviews, are now well enough organized (but not yet automatically) so that incorporating them into the EDUCOM system might be a possibility.

4. Certain portions of the catalogs of the Defense Documentation System, now generally in the open domain, should be candidates for inclusion.

The choice of the portions of these systems to be considered as possible integral parts of an EDUCOM network is a complex one that involves economic, technical, and political questions. It would appear, however,

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that to become a successful undertaking a final EDUCOM system must:

1. Retain independence of the university systems to which it relates and be devoted to the classical aim of the search for knowledge as understood in the universities;

2. Nevertheless, have enough flexibility to cooperate in developments in which the community interest parallels or does not conflict with the classical university interest;

3. Not be the creature of any one group or small clique of universities, or disciplines, or special interests. This means that such a system must not be controlled by or for the computer scientists, the nuclear physicists, the biomedical community, etc., if the full effectiveness of such a system is to be achieved.

Ultimate technical goal. The ultimate goal of the EDUCOM system should be to make available answers to standard types of questions in an abbreviated form and with the shortest possible turn-around time. However, it should be recognized that the capability to do this does not exist at present in any local university information processing systems, and it will not become available without marked further planning. The EDUCOM catalogs and operations themselves should be able to achieve more nearly immediate answers than would any information interchange with the local systems. Therefore, turn-around time will vary with query, complexity, time of day, network use, etc. From the beginning, the response must be markedly better in turn-around time and overall effectiveness than is currently possible. The ultimate goal should be a conversational system with relatively short access to answers. The first systems, therefore, must be planned so that they can be easily modified to provide these later capabilities.

The structure of the network was elaborated further.

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The EDUCOM network is pictured as a central communications core surrounded by two rings of interface and terminal equipment.

At the core of the network is a system of communication channels, called the communications system, which serves all participants and provides for information exchange, presumably in a common standard language.

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Surrounding the communications system are the participating centers, both large and small, which interconnect with the communications system through buffer/translator equipment, called interfaces. Each interface is electrically connected to the communications system at a node. The cooperative use of data and devices at the geographically dispersed centers is the justification for the network. The communications system is simply a means for information interchange, and the interfaces are required to accommodate the many terminal devices (with their multiplicity of electrical, signal, and language characteristics) to the standardized situation of the communications system.

For our immediate purposes, then, EDUNET may be visualized as comprising three rings of equipment:

1. Terminal equipment installed at each participant's location or center. At a small center, this will include one or more remote-access (typewriter and cathode-ray tube) consoles and displays, with perhaps TV equipment for video conferencing as well. At a large center, this will include a substantially larger hardware-software computer complex with time-sharing capabilities.

2. A communications system serving all centers and providing for information interchange among centers; and

3. Interface equipment between the nodes of the communications system and the center's terminal equipment, serving a variety of purposes such as (a) TV modulation/demodulation for TV conferences among geographically dispersed groups, or (b) data buffering, language translation, message editing and formatting, and scheduling of service (queueing of traffic under prescribed priority rules) for computer processing or data search and exchange. It is quite likely that the interface to a large computer center will itself be a small computer of the DEC-PDP8 or IBM 1130 class.

A basic premise that has been made is that the communications system can and will provide sufficient total channel capability to handle peak traffic loading. It is important to note that the EDUNET configuration is radically different from the conventional (telephone) common carrier, and the economics of the system are also radically different. The economic situation is in fact completely reversed in that the cost of communication is an

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Cont.

order of magnitude smaller than the cost of the terminal equipments at the centers. Moreover, these reversed economics will likely hold true for the foreseeable future.

III. EDUCOM-UNIVERSITY RELATIONS

XXX
Friedrich
7/20

In group reports and working papers on the administrative relationship of EDUCOM with institutions in the network, three alternatives have been suggested:

1. That EDUCOM serve as an adviser to network institutions on how to contract for, design, implement, and operate the network and information services provided in the network; or
2. That EDUCOM assume financial and administrative responsibility for the design, implementation, and operation of the network and information services but subcontract most of the operations to other organizations among which will be network institutions; or
3. That EDUCOM assume financial and administrative responsibility for design, implementation, and operation of the network and services. In this case, presumably, it will sell its services to the network institutions.

One group suggested that EDUCOM assume the responsibility for establishing and maintaining only the kernel of the network, with member institutions retaining total responsibility for establishing and controlling terminal equipment and activity. In this structure EDUCOM must establish interface standards. Probably it should bill the network institutions for the use of the kernel of the network.

The EDUCOM Council membership consists of the institutional representatives, who elect sixty percent of the members of the Board of Trustees. This structure enables network institutions to participate in formulating EDUCOM policies and exercise influence in the election of EDUCOM officers. (See Figure 5-1.)

It appears that the present organizational structure provides for satisfactory relationships between EDUCOM and network institutions. No group report nor working paper suggested any basic change.

It is suggested that there a group, made up of actual users of the network in each institution, be set up and

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Friedrich
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Cont.

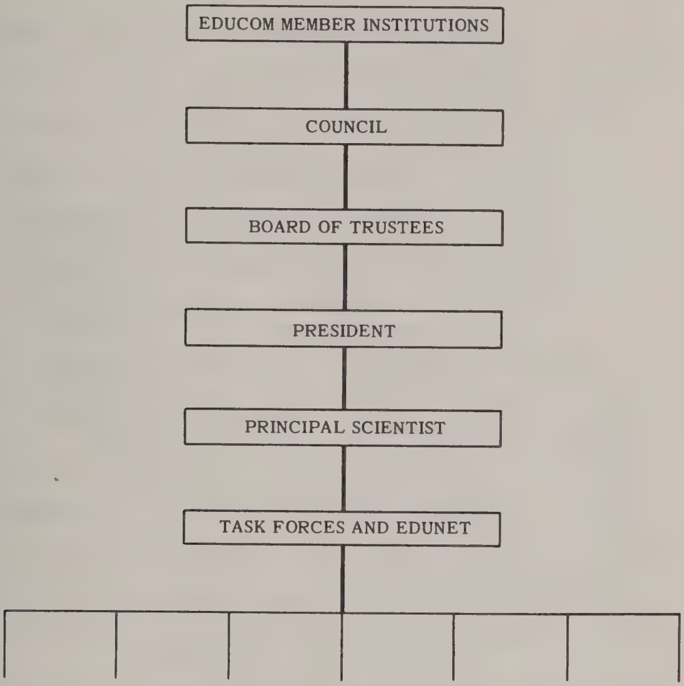

Figure 5-1. Present organizational structure of EDUCOM insofar as it affects administrative relationship with its members. From Group IV Working Paper (7/19/66) by Max Woodbury.

that this be advisory to EDUCOM through its principal scientist.

So far, it has been assumed that network institutions are all members of EDUCOM. If institutions or organizations are admitted into the network which are not EDUCOM members, these should be permitted membership in the users group, but not on the Council.

It would be undesirable to require ratification of major EDUCOM policies by unanimous consent of all the EDUCOM institutions. However, if an institution or small group of institutions objects to a policy set up by the Board of Trustees, effective appeal should be possible. It is suggested that the chairman of the Council appoint a small group, responsible to the Council, which will review appeals and make recommendations to the Council.

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Flint
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Role of university administrations. The increasingly rapid development of systems for the handling, processing, and transmission of information means that university administrations must take an active role in creating awareness of the substantial value of such systems for various educational processes and in promoting use of the systems within university communities. Active administration of information handling and communications should be the responsibility of a vice president who can devote a substantial portion of his time to this function.

The administrative responsibilities involved include:

1. Defining the role in the university of data processing, educational media, computer-assisted learning, etc.;
2. Determining the means of achieving this goal, including facilities, equipment, personnel, and administrative structure;
3. Active and continuing intramural support and development among all facets of the institution;
4. Assignment of priorites in terms of type of activity, amount of time, budget allocations, etc.;
5. Development of proposals for programs including the necessary supports and proper quality control;
6. Budget control and funding;
7. Extramural involvement, possibly in various patterns at various times and for various purposes, with foundations, agencies, other universities, and EDUCOM itself;
8. Miscellaneous considerations of priorities, legalities, and coordination.

With policy and operation in matters of concern to EDUCOM actively controlled at a high academic administrative level, perhaps by a vice president, another individual should be delegated to represent the university in dealings with EDUCOM itself and in other extramural dealings about related or similar matters.

Advice to the administration on policy with respect to EDUCOM and similar matters should be the responsibility of a standing INTRACOM committee (#3 in Figure 5-2), of which the individual delegated to represent the university outside in EDUCOM matters and the vice president concerned should be members. When a policy recommendation is of such a nature as to require the approval of one or more faculties or faculty committees, the chairman of the INTRACOM committee would propose appropriate action to the faculty or faculty committee.

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Flint
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Cont.

Because the effectiveness of the EDUCOM undertaking depends significantly on wide faculty participation and broad representation of the various academic disciplines, the composition of the INTRACOM committee requires special consideration. The INTRACOM committee should represent faculty interests broadly and include a few members of the faculty who are initially not warmly committed to the value of the EDUCOM undertaking. The latter is suggested to minimize the risk that recommendations of the committee will be discounted by some sections of faculty opinion because they consider the committee to be an unrepresentative group.

A network operations group (#6 in Figure 5-2) is deemed advisable, perhaps essential, to assure effective operations and equitable accessibility to the network by users within the university. The chairman of the operations group would be responsible for operational direction and implementation of network services. The chairman, with appropriate staff assistance, would direct the network operational unit, which would keep necessary records of finance, network utilization, etc., within the general policies established by the INTRACOM committee.

The functional realm of the network operations group is seen to be: network budget and finance; priority of access (time sequence); allocation of network resources (time, facilities, funds) among university users; and operational direction of network functions including the interface with the EDUCOM network.

The term USERS (#7 in Figure 5-2) includes all university departments, such as administration, health sciences, libraries, academic departments, and individual faculty or students who might require or request services either from within the university or from the EDUCOM network. Proposals which are not covered by tacit approval on the basis of stated policy should carry appropriate departmental endorsement before submission to the INTRACOM committee for coordination and higher adjudication if required. There is obvious need for ready communication between USERS and the INTRACOM committee to afford effective liaison with EDUCOM concerning new proposals by USERS, and new programs and services from EDUCOM. The relationship allows the INTRACOM committee to exercise its promotional

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Cont.

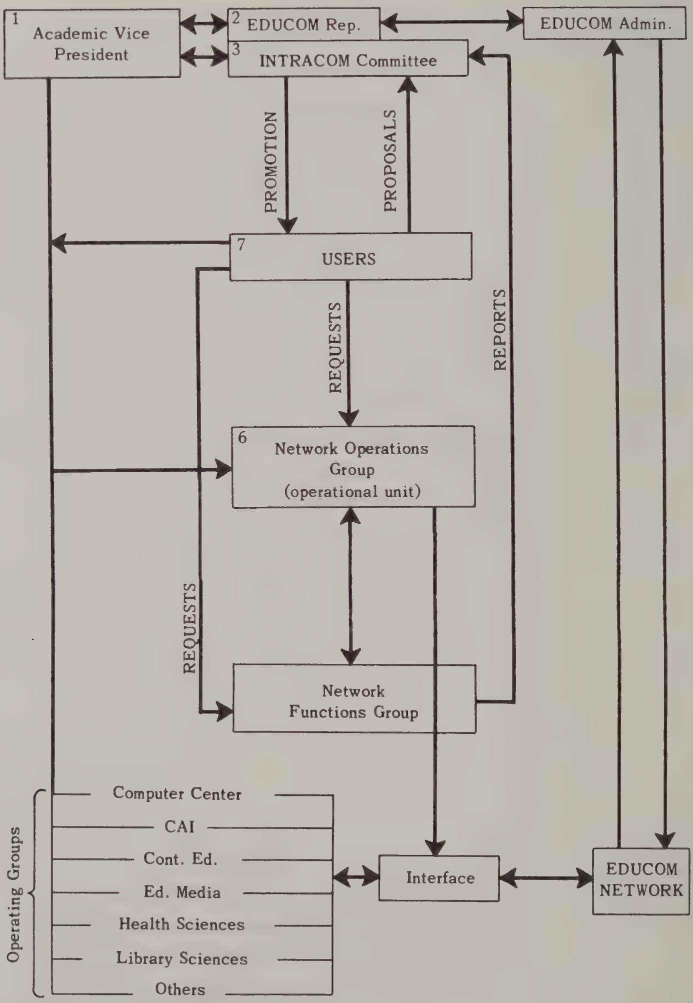

Figure 5-2. Sample University Organization Chart

responsibilities by providing USERS with information on materials available from the network, as well as encouragement for utilization of network services and generation of new ideas.

The network functions group is seen as consisting of the administrators of those operating groups which will have a direct concern with effective network utilization.

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Cont.

Thus, this group will represent the interests of the library, the computer center, continuing education, health science, computer assisted instruction, etc. The network functions group will coordinate and represent network related requests of the users of the facilities of these operating groups to the network operations group. It seems evident that the network functions group will need to work in close cooperation with the INTRACOM committee in reviewing users' proposals and in planning for the development of new network functions.

Normal requests for network service will go directly to the network operations group. Requests that will require new network functions or which, in some way, present a potential conflict for use of the available service capacity should be considered for adjudication by the network functions group. If a satisfactory resolution of the difficulty cannot be achieved by the functions group and the operations group working together, reports on the problem should be submitted to the INTRACOM committee which has access to both the academic vice president and the EDUCOM administrative officers.

This organization is seen simply as a means of generating new ideas, controlling use of the system, and assigning priorities. Any restraints placed on the use of hardware, either by those who wish to use the network or by those who wish intrauniversity use, should be under the direct control of the academic vice president or his representative(s).

XXI
Atchison
7/22

Faculty and student acceptance of EDUCOM. Acceptance on the campus of EDUCOM and the educational aids it offers will be primarily a function of the people associated with EDUCOM locally. It will be particularly important that the principal person associated with the effort be not only professionally competent but also be a good public relations man. He must like people and get along well with them. Essentially, a sales job will have to be performed. University faculty personnel are not automatically motivated to utilize the newest and best educational methods. They will need external encouragement and motivation which can be supplied, at least partially, by proper leadership.

Faculty and student acceptance of EDUCOM can also be a function of the structure within which the local

XXI
Atchison
7/22
Cont.

EDUCOM activities are administratively housed. For example, they should not be housed in the electrical engineering, education, or even in a new computer science department. The structure should be such that all departments and administrative units can be adequately served. The potential effects of EDUCOM are too far reaching to be administered or utilized by only a single department. This is, of course, a function of the local situation, but probably the activities should be administered directly from the office of the vice president for academic affairs or an equivalent position. Faculty acceptance can be stifled by improper administrative housing.

XXIII
Shepherd
7/22

EDUNET and the local representative. During the discussions concerned with the characteristics, applications, and functions of a possible educational network, little (if anything) has been said about the role, function, and capabilities of the local representative on the various campuses. The purpose of this section is to comment on this aspect of our planning.

It is probably a truism to say that the pivotal point on which the network may stand or fall is the network representative at each cooperating institution. This individual will find himself in the crucial position of functioning at one time as the local manager and coordinator for the network use, and at another as an instructor and stimulator for the use of the network. Such a dual capacity will require skills and abilities of an unusual and particular kind.

It would seem reasonable to suggest that already sophisticated machine users will need relatively little persuasion and instruction in the use of a network system. Unfortunately (or vice versa, depending on your point of view), these individuals constitute a very small minority of the university faculty. Our problem will be to discover how we can involve the multitude of faculty who do not now see how to use machines, and who are not interested in doing so. This posture assumes, of course, that we wish to make the proposed network function as a real and vital force in education, and not make it a somewhat limited device designed to meet specific needs.

The comments above suggest that the network representative must have status with the faculty in order to be effective. This means that he would best function if appointed and funded by the institution, and not by EDUCOM.

XXIII
Shepherd
7/22
Cont.

Our description of his role would indicate that he hold either academic or administrative rank, and that he be specifically trained to accomplish the tasks set forth. It might well be, for example, that each network representative receive (prior to assuming his position) a special course of training designed and provided by EDUCOM. At least, he should be thoroughly indoctrinated in the potential and functions of the network system.

While this individual must be an effective manager, his capabilities need to exceed those relatively simple demands. The creative and original uses of the network, particularly in those subject fields not ordinarily involved in machine analysis, will depend (in a large part) on the creative and imaginative qualities of this man. He should know enough about the network system, as well as the subject field, to be able at least to suggest possible relationships between the two.

As routine and pedantic as the task of the local representative may appear to be at first glance, this job may be of primary importance to the successful implementation of the network idea.

A crucial question put forth was, who will be responsible on the campus for promotion, input, use, and evaluation of a network? The discussion below identified the position as that of "technical director."

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Summary
7/22

The basic attributes of the "technical director" appear to be (1) enthusiasm, (2) political position on campus, and (3) knowledge of the range of EDUCOM capabilities. He would report to a vice president or graduate dean for policy decisions and internal support and should be committed to and cognizant of the broad goals of EDUCOM. The technical director should head a committee broadly representative of university interests as they relate to the EDUCOM network.

Whether EDUCOM should have a voice in the choice of this person is a moot question. It must obviously be someone acceptable to both the university and EDUCOM.

Among the responsibilities of the technical director are:

1. Encouraging, where feasible, local data bases useful to EDUCOM;
2. Ascertaining the ability of such data bases to meet the standards of the network;

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Summary
7/22
Cont.

> 3. Promotion of local use of the net;
> 4. Control over network use by local users;
> 5. Development of local training sessions;
> 6. Attendance at training sessions as new data bases are added to the network;
> 7. Maintenance of any files necessary for EDUCOM participation;
> 8. Local evaluation procedures and collection of data.
>
> It should be made clear that this technical director may seldom be the same person who represents the university on the EDUCOM council.

Surprisingly, no real attempt was made to resolve the relationship between libraries and computer centers at network-served universities. At the beginning of the Study, however, the scientific director pointed out that probably the time will come when users neither know nor care whether the information they receive comes from a traditional library or a computer facility.

Intro.
Brown
7/6

> At present, libraries and computer centers are two apparently contrasting institutional forms, each dealing in its own way with the collection, preservation, and transmission of information. One deals with books and documents primarily; the other, with digitally coded programs and data. The library appears to offer very little facility for the logical manipulation of its contents, compared at least with the volume of information stored; the computer center appears to offer primarily the capacity to process information, rather than a significant volume of stored information. Yet the differences may not really be as great as they appear. It seems reasonable to assert that the differences are diminishing, as libraries become increasingly involved in innovations designed to make use of computer technology either to improve the performance of their traditional services or to extend their services, and as computer users become increasingly dependent on accumulating files of programs and data.
>
> Indeed, the introduction of time-sharing makes the computer center into a system which serves clients in parallel, as has been traditional with libraries, except

Intro.
Brown
7/6
Cont.

when two subscribers wish exclusive use of the same item at the same time. One may already ask which will index and catalog the magnetic tapes which may be processed by the computer center on behalf of the library. While it need not be true that the library and computing center will merge into each other and lose their separate identities, it seems likely that the subscriber will ultimately not be able to tell where one ends and the other begins. In this event, he will probably not care, so long as he is well served by the system.

In fact, some appreciation of the common element in the two institutions may be gained by transferring one's attention to the subscriber in relation to the institution. In the case of the library, the user may make use of a general collection, may influence its collecting policy in relation to his special interests, may access special collections when appropriate or cause such special collections to be built, and will normally make his own private collection as well. From the archival purpose at one extreme to the individual collection at the other, there is a continuously increasing emphasis on the specific needs of the individual and an increasing dependence upon the individual himself to cause an item to be added to the collection.

The personal collection may also contain many items, fragments, notes, slides, drawings (perhaps computer programs) of a sort not normally stored in a general library collection. In addition, the personal collection may be organized in a manner which would baffle anyone other than the collector. And why not? Certainly organization of information is a key intellectual element in scholarship, whether it be for the purpose of instruction, research, or the reporting of research; and out of the reorganization of information comes new information at times.

From this point of view the interaction of a scholar with a library becomes less unlike the interaction of the same or another scholar with a computer center. The scholar is much more concerned with the interface between him and the various information systems at his disposal, and with the relation between his inputs and outputs, than with the mechanisms which are behind that interface and which execute his wishes.

The merging of the different orientations toward information in the approach of the subscriber will occur

Intro.
Brown
7/6
Cont.

> when the various technologies, working together, allow maximum opportunity to the individual to create his own files which constitute his own organization of the "literature." Some of the information will lie within the individual's own files; some within the general collections; but together the collections will contain within themselves the information needed to permit ready modification. At appropriate times an individual may organize a subset of his files in a manner suitable for "publication," a process which will require meeting certain standards to ensure general intelligibility to an appropriate subset of other individuals.
>
> The above discussion should serve to indicate the difference in standards required when information is organized for the benefit of others, rather than for private purposes. The concept of the individual scholar may be replaced by concepts of projects, institutes, or other special institutions, with appropriate modification of the notions. The distinction between "private" and one or more levels of community responsibility remains clear, with appropriate dependence on the standards for publication of the community for when the publication is intended, and with obvious implications about the requirement to appoint editors to represent the particular community.
>
> Further, the above discussion was not intended to be exclusive of other media in its concentration on libraries and computer centers. It should be clear that all of the present and future potential media for information origination, storage, processing, transmission, and presentation are to be included. Still further, the notions of private or limited-access files serve to bring administrative information systems into the act.

Although it can hardly be claimed that the foregoing message was reflected in the later work of the Summer Study, there were references to EDUCOM roles in respect to library development, training of personnel, etc., in member institutions. If the multi-media concept on which EDUCOM is based is to be realized, it will require conscious effort along these lines within the institutions as well as within EDUCOM.

IV. RELATIONSHIPS EXTERNAL TO THE UNIVERSITIES

The proposed network will entail numerous interrelationships of various kinds with government, industry, professional societies, foundations, and with assorted segments of the community.

XIII
Witherspoon
7/15

1. There should not be a great clutter of advisory committees superimposed upon technical groups, upon subject matter groups, etc.

2. The network will have several different kinds of relationships, often with the same institutions. There will be subscribers, sources of information and materials, manufacturers, common carriers and other communications groups, funding agencies, public service institutions with special interests, etc. A given university or government agency could fit into perhaps three of those categories.

3. A network must be operated by a professional staff. Policy should come through the EDUCOM structure; advice and help may come from many sources; but administration and operation are professional jobs.

4. EDUCOM seeks to integrate a number of professional interests and technologies which are now typically separate on a campus or within other institutions. The EDUCOM structure should foster this integration and not preserve an out-of-date status quo. Some of the technologies, for example, are those of computers, film, broadcasting, programmed instruction, facsimile and slow-scan TV, microforms, information organization, transmission engineering, and input-output engineering.

At the operations level, under a principal administrator, the following tasks must be performed:

Engineering and maintenance
Research and development
Evaluation
Planning and systems study
Orientation and training, including provision of certain services to user groups
Information service about the network, including the directory service for users and the public information function

XIII
Witherspoon
7/15
Cont.

Relations with users and information sources
Fiscal management, including budget, accounting, and billing
Planning and development of funding
Legal
Scheduling
Office management

XVIII
Summary
7/19

The point was raised that in regard to its relationship with nonuniversity sectors, EDUCOM must consider that there will be other information networks sponsored by government, industries, foundations, etc. The existence and nature of these other networks will influence the organization and functions of EDUCOM. Special interactions may exist with the national libraries and information centers and are indicated in Table 5-1:

Table 5-1. National Library and Information Systems Directors, or Points of Contact for Federal Programs

(Selected Examples)

Department of Health, Education and Welfare	
Public Health Service	
National Library of Medicine	Dr. M. Cummings
National Institutes of Health	
Division of Research Grants, Research Documentation Section	Mrs. L. Cahoon
National Institute of Neurological Diseases and Blindness (regional centers)	Dr. J. Caponio
National Institute of Mental Health (now Bureau status)	
Clearinghouse on Mental Health	Dr. L. Bouthilet
Office of Education	
Educational Research Information Center	Lee Burchinal
U. S. Department of Agriculture	
National Agricultural Library	Dr. F. Mohrhardt

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Summary
7/19
Cont.

Table 5-1--Continued

Department of Commerce	
Clearinghouse for Federal Scientific and Technical Information	Bernard Fry
Department of Defense	
Defense Documentation Center	J. Stegmeir
DOD Programs	W. Carlson
National Aeronautics and Space Administration	J. Stearns
Atomic Energy Commission	Ed Brunenkant
National Science Foundation	Dr. B. Atkinson
Science Information Exchange	Dr. M. E. Freeman

The following example is cited to show ways in which a particular information system can be utilized by the member universities and by EDUCOM in furtherance of plans and programs:

II
Foster
Hersey
7/11

The Science Information Exchange (SIE) is the single source of information concerning on-going research in basic and applied sciences (life, medical, social, physical, engineering) regardless of source of support. The use of this information is restricted to scientific and administrative personnel.

Examples of the use of this information in several contexts are as follows:

A. Operational university programs (by network application when feasible)
  1. Administrative functions
    a. Research support and number of projects going within one's own university, schools, or departments,
    b. Research support and on-going projects within a geographic region or state,

II
Foster
Hersey
7/11
Cont.

- c. Research support to a group of individuals (e.g., all board-certified pathologists),
- d. Location of personnel for staff,
- e. Location of personnel for symposia and committees,
- f. Location of sources of grant support, and
- g. Background material for committee and staff studies.

2. Research functions
    - a. Subject information and contacts for planning of research,
    - b. Avoiding duplication in grant applications,
    - c. Location of knowledgeable personnel in related fields for assistance and discussion during research, and
    - d. Information value in keeping up with one's own and related fields.
3. Teaching functions
    - a. Location of faculty resources in other universities (e.g., for closed circuit TV or as guest lecturers),
    - b. Location of personnel for interdisciplinary seminars,
    - c. Use by graduate students in their planning for research, and
    - d. Information value, in keeping up with one's own and related fields.
4. Services (e.g., Counseling)
    - a. Location of professional personnel, and
    - b. Information value for these personnel.

B. EDUCOM Pilot Networks

1. Offers a possible data base in the use of current research project records on magnetic tape, and

2. Provides assistance in the location of personnel and systems examples.

C. Research in On-Line Subject Searches

1. Possible cooperative project with EDUCOM or

2. SIE research effort of possible later interest to EDUCOM. (A research project of this type is much needed to determine the optimal combinations of human and machine indexing for on-line subject search capability. Such a determination, under the requirements of an actual operating information retrieval system, should be of interest for those network systems whose users will need subject information retrieval.)

The chapter devoted to current configurations and resources (Chapter 2) describes a number of existing and planned regional computer or educational TV networks; the possibilities of interrelationships with such entities were approached primarily with respect to standards of communication, compatibility of information, and fiscal arrangements, to be further discussed in the next section. Very little specific attention was paid to problems of joint planning, for example, with such projects as the Educational Communications System of the National Association of Educational Broadcasters.

EDUCOM will have certain obligations to serve nonuniversity sectors:

XVIII
Davies
7/24

> It is interesting to consider the relationships which now exist between the universities and these sectors. In addition to their major functions of higher education and research, the universities provide such services as:
>
> 1. Continuing education,
> 2. Library and data reference services,
> 3. Consulting,
> 4. Planning, administering, and
> 5. Research.
>
> In return, the universities are tolerated and supported by the rest of society.
>
> It might appear that, in principle, the provision of network services to the outside sectors represents nothing new in light of the services presently provided. The important point, however, is that the network will eventually allow these services to be provided on such a broad scale as to have an altogether new significance.

Along similar lines:

XXVI
McCormick
7/27

> No particular agency or type of institution is categorically to be denied access to EDUNET. Participants may or may not be EDUCOM members. (Instead, the implied basis for participation in the network appears to be a particular agency's contribution toward EDUCOM goals.)

A suggestion:

XXX
Rikli
7/28

EDUCOM-agency relations cannot be solved by delegation to a limited group but will be a prime consideration of all task forces and organizational groups. EDUCOM leadership could identify members of its present organization who would serve as the contact point now for each of the major agencies concerned with EDUCOM's growth and development.

and, with respect to system planning, some recommendations:

II
Interim
Report
7/8

1. That EDUCOM formally request two or more telephone/telegraph companies to designate a small working group to participate on a full-time basis with EDUCOM, or as part of EDUCOM, during the remainder of the Summer Study and on into the fall in engineering planning and design of the EDUCOM network(s). The representatives of the telephone/telegraph industry should be able to advise from a joint technical and management point of view on problems of feasibility, flexibility, organizational interaction, and cost that will arise as unconventional uses of common-carrier facilities are considered.

2. That EDUCOM incorporate into its planning of the proposed network(s) and the activities that will involve the network(s) a number of formally contracted, *quid-pro-quo*, joint activities with commercial organizations in the telephone/telegraph, computer, and television industries (and perhaps others). These joint activities should involve engineers and research people of the commercial organizations directly in some of the EDUCOM activities. We believe that important advantages will flow in both directions in such joint activities and that much more can be accomplished with the aid of joint activities than could be achieved if EDUCOM tried to accomplish the planning and design itself and then let contracts for construction or operation of well defined facilities.

V. FINANCE, CONTROL, AND EVALUATION

This section contains a number of variously interrelated topics, starting from the following nucleus:

VII
Shellow
7/18

1. Fiscal problems of the proposed network
    a. Sources and allocation of funds
        (1) external vs. internal (participant) support
        (2) accounting and billing systems
    b. Billing and auditing of network services
        (1) uniform vs. graded structures
        (2) local vs. remote customers
        (3) copyright compensation for stored material
    c. Balance of trade
2. Priorities in network utilization
    a. Criteria for the establishment of priorities
    b. Supervision and administration of priority structure
3. Standardization and uniformity of practice
    a. Responsibility for translation interfaces
        (1) specification, supervision, and maintenance of hardware and software
4. Software
    a. Ownership of software
        (1) local equipment
        (2) interconnection and communication equipment
    b. Responsibility for integrity of software and authority for software modifications
    c. Mode for creation and expansion of software
    d. Mode for withdrawal of software
5. Orderliness of practice
    a. Traffic control
    b. Network protocol

Closely related to the items above are questions of quality control and security of information in the network, authorization of various classes of services, evaluation of network operations and of service to users, traffic records, and questions of startup and time-phasing. In a few critical areas, important differences of opinion arose and have not been resolved.

With respect to sources of funding:

XXXI
Summary
7/26

> There was strong sentiment to limit the initial number of nodes to some five to ten in order that adequate staffing, local interface equipment, and support for the costs of communications could be provided, to make sure

XXXII
Summary
7/26
Cont.

that a genuinely thorough feasibility demonstration of an operational network could be accomplished in the first three years. From the outset, the network should be expandable to embrace all forty-two EDUCOM universities. It was felt that this system might be financed on a multi-agency grant basis while EDUCOM was simultaneously negotiating a contract for operation of the broader toxicological information network proposed, which would be fully financed at the service nodes and bear a substantial portion of the central computer costs of a system working the EDUNET.

At the local level, questions must be raised as to the distribution of costs. After the initial hardware funding for the interface to the EDUNET has been accomplished, either by EDUCOM grants or from local funds, there still must be a determination as to how funds will be allocated for the three different types of system uses which will occur at a node, viz:

1. Normal use of system, i.e., obtaining services for a campus instructional or research project;
2. Providing input to the system which may later result in type 1 use at other nodes;
3. Overhead and research and development use which will contribute to more effective use of the system and its ultimate improvement.

Ideally, if the system developed proves economically feasible, type 1 use would be billed to the users but some support of communications costs for this type of activity may have to be provided in the initial grants. Furthermore, if use of type 2 is not supported externally from the originating campus (in the case of quality certified input), it is doubtful that EDUNET can develop a useful repertoire of services. Some provision for reimbursing authors of input who hold an established financial interest therein must also be made. To make the network operate effectively, EDUCOM grants must provide substantial support for local participation in research and development activities of type 3.

and

XXXI
Miles
7/28

It is our recommendation that initial external financing of EDUNET be sought in the form of a feasibility demonstration grant which might draw its support from a combination of federal agencies or agency branches.

XXXI
Miles
7/28
Cont.

We feel this feasibility demonstration could be operated by EDUCOM concurrently with one or more high priority application missions funded through separate contracts. However, extreme caution should be taken to avoid undertaking performance of any such specific service mission until the feasibility demonstration has proceeded successfully through the stable operation of a prototype network.

The feasibility proposal must include a carefully developed plan to fabricate and test all aspects—technical, economic, and political—of EDUNET. To be practical, the proposed methodology should include means of studying design, performance, standards, demand projections, and costs for at least three potential EDUCOM applications, through a minimum of two years of actual operation of the prototype EDUNET. Particular emphasis should be given, in the feasibility study, to the economic and operational problems of the university or other user interfaces with EDUNET via relative management responsibilities, sharing of costs and personnel, etc.

It is noted that salaries and collateral overhead support of the proposed prefunding EDUNET staff would probably run over three hundred thousand dollars a year. Although other quickly tappable sources for either contributed staff, overhead items, or funds may be available and should be exploited where practicable, we strongly recommend that vigorous efforts be made to secure a considerable portion of this support from the participating universities. We consider those efforts essential to obtaining the commitments necessary to insure the successful demonstration of EDUNET's feasibility as a cooperative unit. An appreciable initial university contribution of funds and efforts should greatly increase the probability of federal funding of the final major proposal.

In obtaining these initial staff support contributions, thought should be given to the relationship between the EDUNET demonstration prototype network and the contributing universities. A large number of relatively small initial contributions (e.g., $10,000 annually from 30 campuses) has obvious advantages in demonstrating commitment and insuring the long term validity of EDUNET. It may be difficult, however, to offer such a large number of contributors an early involvement in the

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Miles
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Cont.

EDUNET without unduly complicating and expanding the demonstration prototype beyond the range of available funding.

Categories of support from federal agencies will fall in two classes: research and development grants related to broad system capabilities for general service or special application areas or mission-oriented performance contracts of a well defined and predetermined nature. We feel that those sections of the proposal or separate proposals which involve heavily mission-oriented services for the prospective sponsoring agency and cover activities not generally budgeted for in normal university operations should be funded entirely by the supporting agency and that the participating universities of EDUCOM and the EDUNET should receive some benefit from this type of arrangement in cash or services which EDUCOM could use for experimental purposes associated with nonfunded projects important to objectives of its members.

In such a broadly diversified proposal or family of proposals prepared to implement the varied recommendations of this Summer Study, there are elements which would meet guidelines for support of many federal granting or contracting groups. In the National Science Foundation, for instance, parts of the proposal would be of interest to the Computing Science Facility program, the Engineering Development program, the Science Information Section and the Education Section. Within the Office of Education, there would be interest for project ERIC, discussed in a separate working paper, for continuing education, for computer assisted instruction, and for general activity in educational innovation. The interests of various sectors of the vast Public Health Service complex have been well documented elsewhere in the working papers of other groups. The health related aspects of our proposals should not be limited to those ad hoc types of activities well defined and virtually thrust upon us, but should include research and development activities both to produce new knowledge and to find ways to apply existing knowledge to community health services.

Within the Department of Defense there is strong interest in the application of electronic media to accelerate technical training which must be effected quite rapidly

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Cont.

as new weapons systems, communication equipment, planes or missiles move into the operational stages. The State Technical Services Act has objectives which could be greatly aided if bibliographical information available in machine readable form from the new Department of Commerce agency, the Clearinghouse of Federal Scientific and Technical Information, were available via EDUNET universities which would cooperate in providing the services to state industries authorized by the Act. NASA and its science information activities and the Department of Labor and its manpower statistics and its labor retraining programs are other examples of existing data banks that would be made more generally available via EDUNET.

Also pertinent to funding is the following analysis:

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Stewart
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TOPIC: Identification of functions on which EDUNET (EDUCOM) should be ready to negotiate with network members (potential or actual).

If it can be assumed that the Figure 5-3 is essentially correct, the functions to be negotiated will be those listed in #1, #2, and #3, below.

NEGOTIABLE FUNCTIONS:

1. Standards and Regulations
    a. System standards.
    b. Integrity of information.
    c. Authority for modification or destruction of information.
    d. Security of system (public vs. private information, proprietary, classified information).
    e. Priority (traffic) regulations.
    f. Handling of file banks (especially regarding requirements of producer-owners).

2. Management
    a. Clarification (exact) of EDUCOM role and limits.
    b. Clarification (exact) of institutional role and limits.
    c. Legal sanctions, censorship.
    d. Training and supervision of EDUNET personnel.
    e. Production and distribution of educational "promotional" materials regarding EDUCOM for campus use.

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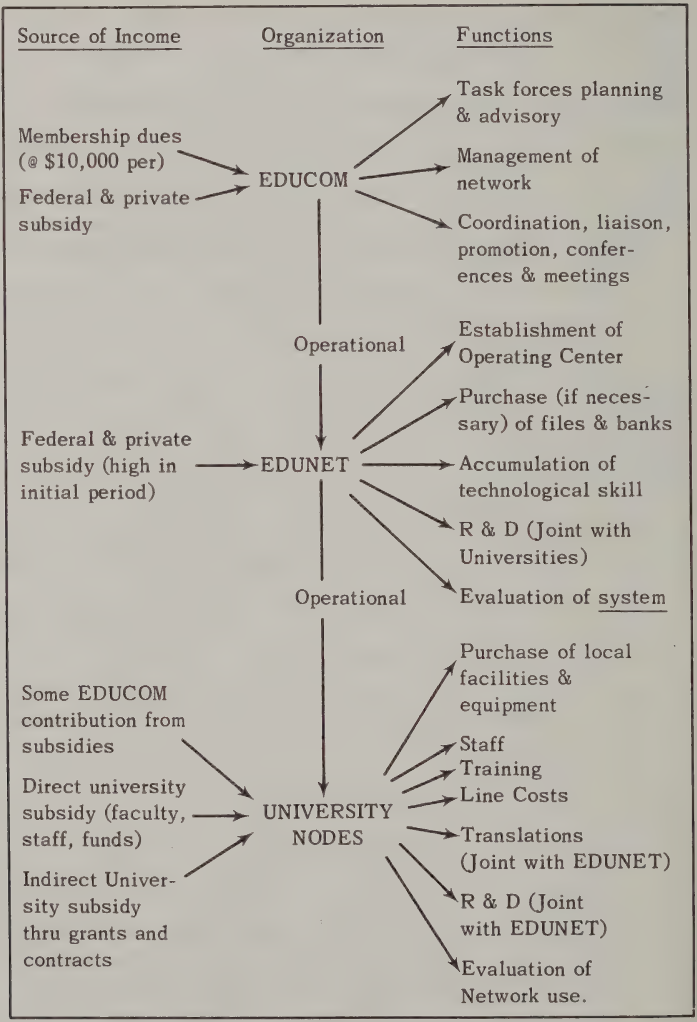
Source of Income
Organization
Functions
Membership dues (@ $10,000 per)
Federal & private subsidy
EDUCOM
Task forces planning & advisory
Management of network
Coordination, liaison, promotion, conferences & meetings
Operational
Establishment of Operating Center
Purchase (if necessary) of files & banks
Federal & private subsidy (high in initial period)
EDUNET
Accumulation of technological skill
R & D (Joint with Universities)
Evaluation of system
Operational
Purchase of local facilities & equipment
Some EDUCOM contribution from subsidies
Staff
Training
Line Costs
Direct university subsidy (faculty, staff, funds)
UNIVERSITY NODES
Translations (Joint with EDUNET)
Indirect University subsidy thru grants and contracts
R & D (Joint with EDUNET)
Evaluation of Network use.

Figure 5-3. Relationship of EDUCOM-EDUNET functions to possible sources of income.

f. Development of methods for evaluation. Evaluation of use of system. Program, planning, budgeting (PPB) function of total network and subsystems thereof.
g. Division of R&D efforts.
h. Translation of data bank materials. Compatibility requirements.

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Cont.

3. *Financial*
   - a. Cost of record-keeping of *use* of system.
   - b. Billing of users.
   - c. Pricing of services supplied by EDUNET.
   - d. Cost of data bank acquisition and subsequent updating.
   - e. Royalty payments on copyrighted material.
   - f. Cost of R&D.
   - g. Possible centralized purchase by EDUCOM of large quantities of necessary nodal equipment (presumably at reduced prices) and subsequent resale to universities; EDUCOM "wholesaling."
   - h. Distribution and allocation of EDUCOM obtained subsidies. Pattern for decisions about who will seek funds for which aspects of system. Clearinghouse function for proposal submission.

The analysis quoted above clearly bears on interinstitutional relations and on EDUCOM roles.

Pricing mechanisms were considered important in financing network operations and in regulating them.

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Haas
McMains
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It is recommended that charges to users for EDUNET services be developed through a pricing mechanism.

Pricing mechanism should provide for consideration of:

1. *Actual costs of services*. Various cost levels will need to be determined for use in the pricing mechanism. Three cost levels are probably adequate: (1) incremental or cash cost of service, i.e., the minimal extra cost of supplying a service (e.g., cost of an additional terminal installed on a per query or time use basis); (2) direct costs to a specified service; (3) total costs of service, i.e., direct costs plus applicable overhead items.

2. *Operating profit*. At steady-state, user prices should include an operating profit component which will permit internal contribution to R&D and the initiation of future new services.

3. *Projected demand*. Prices can be set below total cost break-even, and perhaps below cash cost, at the initiation of a new service if conservatively estimated projected demand is sufficient to permit coverage of all costs, including operating profit, at steady-state.

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4. Competitive services. If EDUNET prices are higher than competitive services (e.g., on-campus, local inter-campus, or commercial alternatives), the network is not economically feasible for these services. Note that allowances for protective trade practices must be included in the demand projections used to establish prices. If demand is not sufficient to justify EDUNET service after saturation of competitive on-campus facilities, the network is again not feasible for this service.

5. Value of service to user. Priorities can be most readily managed through differential pricing. Operating profit at steady-state should be highest for the top-priority service categories.

6. Special cost items. Potential royalty or other use payments must be considered as cost items.

7. Subsidies. Future costs of nonpermanent subsidies from "initiation" or other grants to EDUCOM must be included in estimating steady-state costs. (Remember the railroads and the merchant marine . . . they now belong to Uncle.)

The automatic reimbursement of individual or organizational contributions to EDUNET is not recommended. Adequate quality control of inputs should enable EDUCOM to reward contributors primarily through the prestige of acceptance of their material.

However, network policy should also permit any type of special arrangement for materials required at the discretion of EDUCOM management. Such arrangements would include: purchase, internal production, contractual production, payment of access charges or royalties, etc.

These recommendations imply adequate financial, cost accounting, logging, and billing operations in EDUNET. Costs of these operations are an important overhead item.

Pricing considerations are not affected by differences in network design or applications, but any such differences will change specific cost determinants.

Some additional detail on pricing:

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Stefferud
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Should the network management (perhaps EDUCOM) arrange for the ratable distribution of all costs to those users who derive the benefits? Should the network management pool all revenues (including any direct subsidies and grants) and then allocate resources to users by fiat?

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Stefferud
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Cont.

Or, should an alternative that falls between these two extremes be chosen?

Resource allocation by fiat implies the assumption by network managers of the responsibility for making value judgements of the work and plans of all users and using institutions. The immensity of this responsibility should not be underestimated.

Resource allocation by the method of ratable cost distribution, on the other hand, will relieve the network managers of responsibility for all such value judgements. In this case the value judgements will be made on a decentralized basis. Any institution can then promote its own ideas by simply putting its money where its mouth is or by getting support directly from funding agencies and foundations. This strictly laissez-faire alternative runs the risk that worthwhile ideas which the network managements want to support may go begging because of the fact that none of the users want to deal with them. However, there is no need, with a cost distribution system, to adhere to a strict laissez-faire interpretation. Any compromise between the two aforementioned extremes will mean that network management will have funds for developing and promoting their own ideas while the cost distribution system allows users to do the same. The greatest freedom can be obtained by such a compromise. All parties involved will be free to develop in directions that are appropriate for their own institutions.

Some examples will show this flexibility: (1) small poor schools can be given direct assistance to facilitate their participation; (2) the network can provide seed money to foster development of new areas; (3) the network can interface to any institution with any kind of internal billing mechanism; (4) load sharing problems are simplified because credits obtained from the sale of services can be spent anywhere; (5) users who are sellers or buyers on balance can settle up by simply paying the bill; (6) local interests can be protected because the network can be made to look like another normal user, subject to the normal rules at each institution; and (7) the costing system will satisfy government auditors.

Considerable discussion was devoted to billing and costing, based on notions of Stefferud that bear on the need to maintain an orderly market amongst the various participants, and appealing to the doctrine of comparative advantage. In attempting to make a group revision of Stefferud's contribution a few of the points at issue were as follows:

XVII
Rubinoff
7/23

The notion of a billing system arises in consequence of the need for distributing costs for line usage and pooled equipment owned by network management, presumably including its own computing center. The desirability of management's maintaining records and billing for services supplied by each center to the others appears to be a reasonable extension but is subject to acceptance by the participating centers. There seemed to be general agreement that network management should at least make the billing service available to centers willing to contract for it.

The ratable distribution of costs was downgraded to the function of pricing, and the notion of payment for services rendered was balanced against that of payment for value received. Discussion was discontinued and it was simply noted that the distinction is highly dependent upon the details of the accounting system that is adopted. Nevertheless, the group felt that the subject was of considerable importance in light of the fact that lower cost service is generally provided by larger computer complexes, so that the value received on the largest complex will often be obtained at the lowest cost of service rendered. This places the small centers in an economically disadvantageous position.

It was felt that the balance of payment situation also applies to the trade-off of priorities. In other words, priority is a commodity that can be bartered just like any other commodity such as services or goods. Priorities should accordingly also be distributed both by dollar payment and by rationing of nonreusable tokens.

In contrast with the discussions quoted above, others expressed rather more relaxed attitudes toward billing:

III
Flint
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Recognition or protection (including prestige and financial return) of the contribution of an originator (either a faculty member or a university) to network information is important. Some information will belong in the public domain, subject only to acknowledgement of intellectual indebtedeness (e.g., material analogous to doctoral dissertations or journal articles). Some information will

III
Flint
7/11
Cont.

be subject to classification for reasons of national security or for such legal grounds as those involving invasion of privacy, and should be available only to "cleared" users with a need to know. Some information will be subject to proprietary classification—material analogous to pharmaceutical formulae, to textbooks, or to a standup comic's routines.

Here only instructional material analogous to the textbook is considered.

The suggestion is made that material should be admitted to a network through one of several review boards with a use fee for each module of the material agreed on between the review board and the originator or his agent. A university might act as a faculty member's agent subject to university procedures agreed on in terms of faculty appointment.

Each request for use for a particular purpose would be recorded, and the originator, or his agent, would be compensated as of (say) each December 31.

In the public interest, the availability of such material should not depend on the user's ability to pay. Rather, it is suggested that royalties be paid out of public funds, contingent on the user's establishing an intellectual need to know. The payment of a royalty to the originator would prevent the system's having an excessive "leveling down" effect.

XXI
Adelson
7/20

It is clear that member institutions will benefit differentially from participation in any network and will contribute differentially. The notion of equitable payment, if carried too far, could mean excessive accounting costs. It might be interesting to explore the idea of classifying network participants into perhaps seven categories on the basis of some estimate of their total contribution to the network. Then some function of their contribution could be subtracted from the payment appropriate for the category of user to which they belong, thus (a) providing incentives to contribute, (b) not unduly penalizing small institutions that use more than they contribute, but do not use much in an absolute sense, (c) allowing flexibility in rate structure through variations in prices and credits to different classes of institutions.

Also in reference to interlibrary loan charges:

IV Summary 7/13

"Let us remove them" was suggested; a countersuggestion was that the computing network note the borrowing transactions and establish a balance of payments bookkeeping system.

The question of nonnetwork service costs was raised:

XVII Hayes 7/21

Hidden among the issues of costs in general is a specific problem—the burden placed upon the individual institution independent of the network costs themselves. The present pattern of interlibrary loans provides an analogy. Although there is a presumption of reciprocity in the existing interlibrary loan systems, it is well known that larger university libraries lend significantly more than they borrow. The resulting inequities are generally ignored, since the total traffic, and thus the cost to any individual library, is of a size that can be absorbed in the interest of the general welfare. The effects of a national network may not change the general pattern of such services, but it will substantially increase the traffic. Thus the university with a wealth of resources may find its costs skyrocketing to the point where they cannot be absorbed. Since libraries are regarded as an integral part of the EDUCOM network plan, this becomes a significant issue for them; and it almost certainly will arise in other areas as well. For this reason, it is imperative that mechanisms for resolving these inequities be defined.

1. A schedule of payments, based upon number of requests processed. This alternative recognizes that the well-endowed universities are providing more than simply content—whether books, data bases, or programs; they are providing services as well. In the case of the library, these include reference services to check the validity of the request (and usually to correct it) and to determine its availability. Should payment be based on the costs incurred for services as well as content?

2. A schedule of payments, based upon number of requests satisfied. This alternative recognizes that frequently the request cannot be satisfied. Should payment be based on value received for particular services?

3. Contractual arrangements, such as used with the MEDLARS subcenters, which would recognize the costs of such services provided by the centers of excellence

XVII
Hayes
7/21
Cont.

and make it possible to avoid pricing of an individual service.

4. Reimbursement of costs, as a burden on the general network charge for its utilization based upon some accounting for total costs of network services.
5. Bi-party (or multi-party) contracts providing for a mutually acceptable basis for equalization.
6. Some combination of these.

Some concern with the problem of "have-not" institutions was in evidence; in one case the concern was stated against a background assumption that the system would be self supporting:

XVII
Caffrey
7/25

The following are among suggested principles or policies stemming from a basic user-oriented philosophy:

1. Users must pay for what they demand.
2. The network must provide whatever the user can pay for, within the limits of technical feasibility and of the interests of other user communities.
3. Users should bear equitable (not necessarily equal) shares of common costs of developments they demand or accept.
4. The system must ultimately be self-supporting.
5. Ability to meet the costs of participation in the system should not be the only determinant of membership—especially when it is to the interest of other users to include certain members in the system.

and in another case:

XXVI
McCormick
7/27

In addition, the existing EDUCOM membership itself is not homogeneous. Allowance must be made for indigent members (and users)—even if they do not have adequate funding for direct contributions to the "hard" system.

A related point was raised in connection with billing:

XIII
Summary
7/12

Users are not all of the same class. Should a distinction be made in billing among nonprofit educational users, industrial users, users in private professional practice, etc?

General agreement existed concerning the need to compensate authors or sources of materials, but not with respect to principles or mechanisms. In connection with the preparation of instructional materials:

III
Summary
7/11

Many problems of materials preparation and distribution need to be discussed. Careful development requires money, technical support, and much time from a subject expert.

Time must be released and support provided. Probably monetary rewards should be used to attract investors (whether institutions, industry, or individuals), while the subject expert should receive recognition for his contribution to the field in terms of progress toward promotion and salary increases.

The academic recognition assumes that the materials pass some editing or screening test of his colleagues in the field.

In connection with "publications:"

XXI
Adelson
7/20

There will undoubtedly have to be some important change in the concept of a sale of a book if publishers and others who prepare materials are to be appropriately recompensed. One potential solution to this problem is to replace the system in which the individual student or faculty member purchases such material in the form of a book by a system in which a single copy of the material is purchased by the institution and made available to all of its members, students and faculty alike, through any means it likes. The price paid by the institution for the "book" under these circumstances would have to be relatively high; but this cost could, if necessary, be recovered in various ways from local students and faculty as well as from other network users.

Elsewhere, the need was identified for:

XVIII
Summary
7/19

1. Constraints to recognize and protect the authorship rights of individuals and organizations. This relates to copyrights, patents, and other forms of proprietorship.

2. Constraints to protect against the use of EDUCOM to avoid payment to a corporation which offers certain information for sale but which would like to make it available through EDUCOM.

A suggestion:

XVIII
Summary
7/21

How to compensate contributors of information services was discussed at length. The ASCAP approach to this problem was discussed. A modified version of this might make sense for EDUCOM. Rates for various information services could be periodically negotiated with the suppliers of the service. Use of the service would be established by statistical sampling (or detailed accounting). The compensation would be the product of rate and usage.

Materials used by or through the network will include software, either in the form of programs or other information. Related to questions of compensation are the basic elements of the concept of ownership:

XVII
Shellow
7/20

These inquiries are directed to the questions of the extent to which software may be owned, the incidents of this ownership, and the consequences of the correlative rights and duties created by these incidents. Ownership consists of a bundle of more or less important controls; typically, ownership involves one or more of the following incidents:

1. The right to possess the product;
2. The right to modify the product;
3. The right to be compensated for the use by others of the product;
4. The right to destroy the product or to withdraw it from the market;
5. The right selectively to relinquish the incidents of ownership;
    a. The right to restrict the copying or use of the product,
    b. The right to license others to distribute or modify the product.

Some of the information stored in the network will have been copyrighted; some of the information stored in the network will be the subject of negotiated contracts between participants and the network. Questions concerning what constitutes an "expression" and what constitutes "publication" within a computer-based information network cannot be realistically resolved within the structure of the existing copyright laws. Thus, this

XVII
Shellow
7/20
Cont.

> paper will not consider the infringement consequences of a network operation and will treat the ownership of software as a matter of private contract between the interested parties.

Related to the previous quotation is the following scheme:

XVII
Schwartz
7/22

> Software which exists in the network (outside of executive routines) can be classified in two ways. It can be public or private. Private software is that whose access is limited to an individual (usually the originator) who has complete control over its disposition (e.g., rights to modify, destroy, or relinquish the incidents of ownership). He pays for the right to produce, run, and store these files. In turn, the local system protects its integrity in the way he desires.
>
> The second class of software is public. Incidents of ownership of this software belong to the network administration, who in turn "compensate" the individual who has provided the software. In order for software to become public, certain conditions must be fulfilled. It must be adequately documented, and the network management must verify that the operation conforms with the specifications. It is proposed that any authorized user have execution and read access (including the ability to copy) to public files.
>
> It seems as though there may also be a need for a mode of public files which permits the originator to maintain the right to modify (for experimentation purposes, for example). In this case, the documentation as well as the contract between the originator and the network administration would have to state this clearly. This latter mode should be the exception, rather than the rule.

It is appropriate at this point to bring in questions of security, authorization for services, and quality of information. An extreme position was stated as follows:

XVIII
Grabbe
7/19

> The problem to which this paper is addressed is whether the complete information files of the EDUCOM network system should contain only information in the public domain and hence should be "open" to all users.
>
> The group has interpreted its scope to include Network Relationships "Outside the University"--including

XVIII
Grabbe
7/19
Cont.

government, industry, professional societies, foundations, professions, other information handling groups, and the public at large.

The on-line services that would be provided by an EDUCOM network would include bibliographical information, nondocumentary information, library of programs, CAL, TV and audio, and problem solving capabilities. One position to take is that there should be a minimum of constraints on the use of all EDUCOM services by groups outside the university.

The advantages of this position are as follows:

1. Restrictions on information are often traditional or political rather than logical. Having open EDUCOM files would encourage all contributors to declassify much information.

2. Open files would discourage monopolistic positions that might develop from restricted access.

3. An open system would be more acceptable to government agencies funding EDUCOM network applications and would be compatible with the concept of service to the community as a whole.

4. Universities traditionally have made information available speedily to the public.

5. With open files EDUCOM would not have the responsibilities of policing restrictions or accidental release of restricted information.

6. Once a large open file is constructed many users would discover that much supposedly restricted information was indeed available from other unrestricted sources.

7. The use of the EDUCOM network for restricted files, say in research fields, might lead to impersonal man-machine discourse by research personnel that would not be as stimulating as personal contacts by phone or mail with other research personnel.

8. For initial network trials the advantages of an open system are:

   a. ease of programming,
   b. services for all users,
   c. all operations may be publicized.

9. An open system would avoid the problem of special charges for use of restricted services.

10. It may well turn out that cost factors (programming, storage, etc.) will prohibit use of the EDUCOM network for restricted material.

> XVIII
> Grabbe
> 7/19 Cont.
>
> Restrictions on inappropriate use of information and other constraints might be handled by judicious editing of the material by the contributors before input.

It is clear that this position was not generally adopted:

> XVIII
> Summary
> 7/21
>
> The question of privacy of files was discussed again. The group is sharply divided on this subject.

Reference was made to the special situation of the health area:

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> Summary
> 7/19
>
> Content of data bases may contain unique features that demand unusual security measures.
>
> The repercussions of inappropriate use of some medical data are so great that it may be necessary to provide a review mechanism for evaluating the use being made of certain jobs.

Without specific references to the sources in the Summer Study, it seems desirable to pull together some of the arguments against the position which advocates complete openness of information:

1. Collaborative research efforts would be inhibited.

2. Grading mechanisms open to instructors should not necessarily be available to students.

3. It may not be advisable to publish system programs which determine operating characteristics, as protection against malicious mischief.

4. Publication of certain classes of data in raw form may infringe upon the privacy of individuals, including usage data collected for the evaluation of network operations or applications.

5. It seems inevitable that classes of user authorizations must exist for files of the system, in view of contractual agreements which may pertain to sources of materials and guarantees of service to certain institutions or individuals, the

need to qualify users of certain services in order to avoid waste of resources, the need to allocate information resources within the university, and the need to control the total load on the system in order to avoid system breakdown or usurpation.

The need for quality control of information in the system was stressed in a number of places. The general impression is that EDUCOM must set standards and review procedures for materials originating outside the EDUCOM organization, without attempting to take responsibility for the information itself, beyond assuring proper and accurate processing.

The need for quality control in systems operation brings in questions of software integrity:

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Schwartz
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> In a network where all centers are essentially equal, the protection of any file rests in each local center just as it does in a stand-alone time-sharing system. If a file is labelled public, the local system must assure that no program or user can modify the file (by causing error traps to occur when unauthorized access is requested). If a file is private or restricted to local users or to a limited set of users, the local center must verify the user's identification and give him access only if authorized. Of course, complete incidents of ownership are available to originators of private files. No one other than originators can delete private files from the system.
>
> The dichotomy between public and private files as well as various modes of protection for private files (e.g., read, write, execute) serves as a satisfactory means for preservation of integrity. Basic techniques for implementing these modes include file-naming conventions which include organization, originator, and file name for each file; maintenance of a local inventory at each center; and hardware as well as software protection at each node to prohibit unauthorized (accidental or intentional) access to files. Since the originator of public files is giving up certain rights to them as well as making an authorized contribution to the network, credits for this action should be given to the originating institution by the network administrator. The value of the particular contribution is going to be difficult to assess.

Also related are questions of priorities and scheduling to assure orderly systems operation. The mechanism of charging was viewed as a means of limiting demand:

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> In the early months of operation, it is certain that the service will have to be given on an experimental basis, thus unguaranteed. Consequently, all service will be free. Eventually, however, the service should be reliable and valuable enough so that there is a demand for it, and presumably more demand than supply, if all users had their option. For example, there would probably be an overwhelming number of requests for "instantaneous" service at 10 A.M. and 3 P.M. One must somehow adjust the demand to meet the supply in this situation since it is impractical to consider adjusting the supply upward beyond a point.
>
> One technique for doing this is the equitable allocation of space and time by administrative fiat. This is probably an overwhelming problem in a network since the predicting of communication paths and computing facilities required by any user would be quite unwieldy. Also the feelings of unfair treatment will probably tend to proliferate.
>
> A second technique is the assignment of priorities among the users, where a user with a lower priority will have to give up computing time, storage space, communications channels, etc., when users with higher priorities request them. This would certainly lead to a series of grumblings, both regarding the assignment of priorities and the results of being "bumped" for higher priority users.
>
> The third technique is control through charging. The assumption here is that a proper pricing scheme would tend to channel the demand, so that more optimal equipment and software utilization is attained. A simple scheme such as a flat fee per "console hour" could be used, but it would not tend to moderate demands for scarce equipment. Thus a more elaborate scheme seems to be necessary—one whose rates are proportional to the value of the service. This would be modified in a network because the rates for the same kind of service may vary among the installations. Communication costs would also be charged to the user as well. One problem with this scheme is the not insignificant overhead attached

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to keeping records during the operations. Estimates range from 5 to 40 percent of total system capacity for this function alone. Perhaps with the years, hardware meters can be developed which will decrease this expense.

By whatever means, it seems clear that priorities and reservation systems will be required to assure certain classes of users appropriate quality of service, which may be important for a number of reasons. Some observations:

XVII Oettinger 7/22

Priority Considerations

Whatever system of switching (wire switching or message switching) is used in the network, there will be messages of varying degrees of priority. For example, consider on-line interaction with a remote computer or a data-exchange connection between two computers. Such a situation is characterized by the need to establish a connection fairly rapidly, hold it for a message, burst, and then release it. In message switching systems, this implies minimal delay, i.e., brief store and prompt forwarding. In wire switching, it implies rapid and reliable switching, hold, and release.

These demands are more stringent than those for more routine messages or noninteractive data base queues. The network must provide such facilities and a rate scale which puts a premium (but not an exorbitant price) on high priority messages.

Addendum by the Group

The group concurs in the preceding comments and recognizes the variations in needs for access to the network. It would like to draw attention also to a related consideration on priorities used for such purposes. Priorities do not necessarily carry full assurance of access in times of network congestion. It should therefore be kept in mind that priorities imply and involve the probability of failure, and the reduction of failure probability can normally be attained only through increased cost.

and

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Any network designed to handle all peak loads is clearly over-designed. Therefore we must assume that on some occasions peak loads will cause temporary congestion in any realistic network implementation.

Peak load congestion can be handled in a number of ways. Queueing disciplines will clear the overload in an orderly way by making users wait their turn. By adding priorities, these queueing disciplines can provide relatively better service for some users than for others. However, priorities cannot provide unconditional guarantees. An unconditional guarantee of access (given the facility is operational) can only be provided by a priority system if preemptive priorities are issued to no more users than can be served simultaneously. Otherwise, the guarantee will fail on occurrence of a peak load.

If there are more users on a network who want preemptive priority rights than can be provided at one time, then these rights must be scheduled (allocated to users for specific periods of time) in advance, unless all users wish to take their chances on availability of preemptive rights. The required scheduling in advance is usually handled by a reservation mechanism. Reservation mechanisms typically arise where a facility (or right) cannot be shared (preemptive rights cannot) and where the facility users wish to plan ahead with a high degree of certainty that their plans will materialize.

The conclusion of this paper is that in the network(s) under consideration, it will be highly desirable to schedule in advance all use and maintenance of important facilities. An important facility is taken to be any facility or preemptive right to service that users plan to use with a high expectation of materialization of their plans. This conclusion is perhaps best expressed as a proposal that the network should include a reservation system which will take the form of a service to users which they can use to plan their use of network facilities.

Kinds of priority treatment were listed:

XVII
Caffrey
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Priority is not a simple matter; there are several kinds and issues:

- entry into the system (being able to plug in);
- preferential treatment in the stack or queue;
- quality of response;
- efficiency of operation;
- user-priority vs. job-type priority;
- levels of hardware, including storage capacity.

Related to the quality of systems operation is the problem of evaluation, required for evolutionary development of the system and its operating procedures, for justification of continuing support, and for efficient management of the system:

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Summary
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The major aims of the evaluation of the pilot project would be to determine the identity and extent of the achievements that the network has made and the effect it has had in the selected discipline. Such an evaluation would require that each user make both an a priori and an a posteriori report in depth on each identifiable application. In addition a complete statistical reporting system on network usage would be needed.

The a priori report would include such items as:

1. Statement of problem to be attacked;
2. Proposed program of action,
    a. Identifiable steps in the program,
    b. Proposed time schedule,
    c. Proposed network usage,
    d. Proposed network techniques;
3. Alternate programs available for problem solution not involving the network;
4. A priori assessment of network contributions to the program,
    a. Value placed on network services,
    b. Anticipated efficiencies in the program due to the network;
5. Benefits expected to accrue from solving the problem.

The a posteriori report would cover such items as:

1. Statement of problem solved or attacked;
2. Detailed description of the solution or progress toward the solution;
3. Actual program followed in work,
    a. Program steps,
    b. Actual time schedule,
    c. Network usage,
    d. Network techniques employed in work;
4. Evaluation of network contributions to work,
    a. Value of network services received,
    b. Contributions to efficiency,
    c. Goals that were reached that were unattainable prior to the network's existence,
    d. Network deficiencies;

XIII
Summary
7/18
Cont.

5. Details of new or unexpected network techniques or concepts resulting from study;
6. Actual benefits accruing from problem solution including implications for network;
7. Recommended or envisioned extensions of work or evolution of application.

Once the permanent network is established, the primary purposes of evaluation would be to insure that the system remains adaptive to the needs of the users and to support research and development on advanced network concepts and equipment. Again statistical data would be needed in evaluating the adequacy of the current system and would be valuable in recognizing changes in usage patterns and requirements. A built-in system for user feedback would be essential in determining near-future needs and current inadequacies of the network. Finally, detailed users' reports would be required in monitoring areas of significant developments and to support network research and development projects. These latter reports would be similar to the users' reports required in the pilot project.

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Mood
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Ideally, a plan of evaluation would put no requirement whatever on the user because such requirements reduce the utility of the network to him. A network which contains computers can go far toward eliminating the need for the user to supply information about his usage. Thus, there can be automatic recording of the stations of origin and destination of a transmission, the time of origin, the duration of the connection, the number of words or characters transmitted back and forth in the course of the duration, etc. In fact the entire content can be recorded. But the help of the user cannot be completely eliminated because it is too often impossible to deduce the purpose of a message (or conversation) from its content.

This consideration brings to mind the accounting problem which could much reduce the effectiveness of a network if the user is to be required to help the accounting department allocate the cost of his usage. Hopefully the network will be a free service as is the intracampus telephone system, so far as the user is concerned; accounting information should be recorded automatically.

The speculations of the earlier sections are intended to make reasonable the proposition that a satisfactory evaluation can be carried out if the originator of a usage

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Mood
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Cont.

of the network will code his type of usage on a single digit as follows:

0. Communication with a collaborator in research on another campus;

1. Any other usage involving a person on another campus in research; for example, as a source of information, as an expert in a technique, as a consultant, as the possessor of a demonstration, equipment, or material, etc.;

2. Any usage of materials, equipment, or facilities on another campus in research in a way that requires feedback;

3. Any usage of materials, equipment, or facilities on another campus in research in a way that does not require feedback;

4. Any usage involving a person on another campus for teaching; for example, guest lecturer, consultation on teaching, demonstration, curriculum committee, Ph.D. committee, thesis adviser, etc.;

5. Usage of materials, equipment, or facilities on another campus for teaching in a way that does require feedback;

6. Usage of materials, equipment, or facilities on another campus for teaching in a way that does not require feedback;

7. Usage for university administration;

8. Usage for network development and administration;

9. Other usage (including public service).

Some arbitrary definition is needed with regard to the necessity for feedback which differentiates code 2 from code 3 and code 5 from code 6. Almost any long telephone conversation, for example, could have been replaced by an exchange of letters if the originator of the conversation could have been persuaded to write down very elaborate and unambiguous specifications (covering all sequential contingencies) about the information he desired to obtain from the conversation. Thus a line needs to be drawn, but perhaps only hazily, by something like this: feedback is necessary in an exchange of information, so far as the above coding system is concerned, if an accurate unambiguous specification of the information would require more than a one-page letter.

The evaluation plan can and should change from time to time as one obtains a better understanding of the actual role of the network in the life of the universities

III
Mood
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Cont.

which it connects. Thus we need be concerned here mainly with the first phase of the evaluation plan which might cover a period of three to six months.

It is proposed that the following data be recorded by the network for the first phase of evaluation:

1. For every usage record:
   Originator and his station,
   Time of request for channel,
   Time channel is made available,
   Responder and his station,
   Type of usage code specified above,
   Time of completion of usage.
2. For every twentieth usage (actually for every usage with probability 0.05) make a complete record of the content if the duration is less than three minutes or the first three minutes if it is longer.

Most of the items in 1 will probably be required for other purposes anyway; thus each user will probably be assigned a number from which one can deduce his name, department, and campus.

The first phase evaluation would consist simply of a statistical analysis of these data. The analysis would display the traffic patterns, examine the accuracy of type of usage coding by inspecting a sample of the recorded usages, determine the distributions of usages over the type of usage code, the campuses, the university departments, etc.; these distributions would be by frequency of usage. One would also estimate the total time the network was used by various departments and persons in the ways specified by the type of usage code. Some analysis of the content sample would be made to determine the extent to which the network was being used as a convenient substitute for the telephone or the mail.

These analyses would comprise the first phase evaluation and would supply the basis for specifying the next phase of the evaluation which might merely modify the first by changing the type of usage code and by recording content with different probabilities for different code numbers. On the other hand, particularly if some of the speculations of this paper turn out to have been quite wrong, the evaluation plan may have to be completely redesigned.

An interesting auxiliary evaluation over a longer period of time could be made from the list of publications

III
Mood
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Cont.

> which most universities obtain from their faculty members each year. Several annual series of indices would be relevant: for each member institution one would particularly like to see the number of publications per faculty member and also, the proportion of total publications which are joint publications between faculty members on different campuses. One might also examine the relationship, if any, of these indices to the amount and frequency of network usage by the institution.

The amount of record-keeping suggested may turn out to be prohibitive; the suggestion for sampling content may perhaps be applied to the noncontent record-keeping, and there is at least some discontent with the notion of recording the content:

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Adler
7/26

> Who talks to whom for how long and what facilities were used seem important. My indoctrination in "Secrecy of Communication" leads me away from keeping track of what the transmission was about.

There was general agreement that record-keeping should be built in and should not burden the user:

XXVI
Caffrey
7/26

> The total system should be designed to do its own bookkeeping and accounting functions—keeping track of usage, hours, volumes, times, etc.—both for evaluation of the system and management of costs. Data about the status of the system and its elements should be available both to its users and to its operators at any time. This will be especially necessary whenever resources are limited—i.e., in almost every case and for some time to come. Experience with time-sharing systems shows, for example, that users very often want to know whether and how many channels or storage areas are available, how many other users there are, whether they can schedule use of the system at pre-determined times, how much of their allotted time has been expended, etc.

In connection with the evaluation problem questions arise about the position to be taken with respect to early applications of the network:

XIII
Summary
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> The task of network evaluation can be divided into two phases: the evaluation of the pilot project and the continuing evaluation of the established network. This division is due to the differing major goals that an evaluation would have in these instances.
>
> First, it is suggested that the resources available to the pilot project, in addition to those resources required to establish the communications network, be directed toward applications in one particular discipline. Particularly in terms of justifying continuing support, it seems that significant contributions and achievements in a limited area would be much more valuable than a large number of minor contributions across many fields. The communications capability of the network should not be restricted or denied any discipline except as necessary, on a priority basis, to accomplish selected goals. Care should be exercised to insure that those applications selected for support in depth are typical of other disciplines and are easily generalized.

But note the disagreement expressed in connection with library applications, where it was concluded that it would be most important to have library applications which:

IV
Summary
7/18

> Represent as many substantive subject interests of universities as possible, so that sufficient excitement would be generated among potential users to enhance the probability of success.

Considerable attention was given to the question of institutions to be included in the initial stage:

XXX
R. Miller
7/28

> There appear to be some obvious criteria for the selection of institutions to be included in the original EDUCOM network. Although it is difficult and may not be necessary to assign a priority for selection, it would seem that the first requirement should be a *strong interest* by the university in becoming a part of the network plus considerable interest and working knowledge on the part of its faculty. Where this interest and knowledge exist there may also be an accumulation of hardware which could be readily usable in a network with machine-readable programs already in storage.
>
> The *geographical location* of a university may prove to be a consideration in terms of the distances involved.

XXX
R. Miller
7/28
Cont.

It may be desirable to concentrate the network in a comparatively limited area of the country. On the other hand, as the network is formed, emphasis may be placed on selecting universities with a rather widespread coverage of the U. S. instead of maintaining a closely-knit group in one section.

The funding capability of a university may be a relatively important criterion. This would demand consideration of the costs involved for each institution in carrying its share of the financial load for necessary equipment purchases as well as any contribution to EDUCOM and for network service once it is established.

It is possible that considerations of inter-relationships between educational institutions and/or key personnel may play a part in any final selection. Although this criterion may not carry a high priority, it is entirely possible that those considerations may be more important in the selection than even faculty interest or available hardware. While this reason may not receive much visibility, it could well be of major importance in the selection of institutions for the prototype network.

Several other criteria should be discussed here which may or may not play an important role in the choice of universities for the original network but also may provide a selection system when other factors are comparatively equal.

It may be prudent in the original selection for a network to pick at least one relatively undeveloped university as part of the first group in order to provide an evaluation of EDUCOM from the standpoint of assistance to such an institution. What costs are involved in getting started? How long did it take to secure necessary hardware and faculty interest? Are funds easier to obtain for a school which is starting from scratch? What is the prognosis for the acceptance of new capabilities? What problems are posed to EDUCOM in such a situation? Can EDUCOM provide leadership and guidance to such a school?

It may be wise to consider the relevance of a given university's program in relation to the services available on the network. If there is very little connection between the curricular emphases at the institution and the materials available from the network, would the selection of this institution be inappropriate from the

XXX
R. Miller
7/28
Cont.

standpoint of making good use of the network? What special changes would the school carry out if it should be selected? Would the promise of such changes be of interest to EDUCOM in terms of future support?

Perhaps in the first phase of the network it would be important to include at least one institution where EDUCOM could play a part in helping it acquire faculty and hardware capabilities. Would such a consideration be viewed with favor in funding quarters because it would provide evidence that EDUCOM was not depending totally on a network of large universities to insure a propitious beginning?

It may be that an important consideration in the selection of a university would be its being a unique repository of knowledge. Perhaps it has a specialized library of rare books, special disciplines, or a particularly desirable reputation as an outstanding institution in a specialized field.

Another consideration for selection might be the opportunity to provide an ability for match sharing between two great universities. It could be that such sharing would help eradicate past rivalries or competition between such schools and at the same time would open up valuable resources to others.

Another criterion might be the ability of a given institution to provide wide dissemination of network information to other schools in the area. Such could be the case where the university is already serving as a regional distribution center. This selection might offer a wider acceptance to EDUCOM services and might be helpful in adding new schools to the network after Phase One has been completed.

And finally, it might be worthwhile to select an institution noted for its research capabilities, for example, the Mayo Clinic which could become a part of the network through the University of Minnesota and might thereby make available to many medical schools results of on-going research in heart disease, cancer and stroke. Such a selection could result in an effective use of the network and at the same time provide new storage data.

In summary, the following priorities are suggested for selection criteria keeping in mind that other special considerations might cause some change in precedence:

XXX
R. Miller
7/28
Cont.

1. Demonstrated university interest in becoming a part of the network;
2. Available hardware;
3. Availability of machine-readable programs and other stored data;
4. Faculty interest and capabilities;
5. Funding capabilities;
6. Geographical location;
7. Relevance of the university's program to resources of the network;
8. Selection of an under-developed university for EDUCOM assistance;
9. Selection of a university for EDUCOM assistance in acquisition of faculty, hardware, etc.;
10. Selection based on the university's being a repository of unique knowledge;
11. Selection based on a regional dissemination capability;
12. Selection based on the institution's unusual research capabilities;
13. Selection made on the opportunity to provide "matched sharing."

There are undoubtedly other important criteria which cannot be foreseen at this time but which may develop because of special considerations of the moment. In any case, the criteria listed here should provide some practical guidelines for selection of universities to be a part of the original network. The same criteria could be utilized with appropriate changes in priority for selection of future additions to the network.

Concern was also expressed for the time-phasing of finance and control methods. In connection with the work of Group XVII, it was observed that:

XVII
Hayes
7/21

Most of the discussion has concerned the issues of finance and control during normal day-to-day operation. It must be recognized that the same functions arise during the period of experimentation, development, and implementation. Furthermore, the answers for those questions will be different in the two phases. And perhaps most important, the transition from the one mode of finance and control (experimental) to the other (operational) must be as carefully planned as the technical transitions.

XVII
Hayes
7/21
Cont.

The specifications, requirements for control, and methods for financing a project as complex as the EDUCOM network must be planned in as carefully scheduled a progression of steps as are the more technical aspects of hardware and software. In particular, it would be foolhardy to expect that the specifications, control, and methods for financing which would be appropriate to an ultimate, operational stage could be met in earlier experimental and developmental ones. On the other hand, it would be short-sighted to proceed as though the eventual requirements in these more or less nontechnical aspects would, in some way, naturally evolve out of the experience during earlier stages.

VI. NETWORK-INDUCED ROLES OF EDUCOM

Almost without regard to the particular topology of the network design itself, it has already become clear that there are certain minimal roles which must be played, either in the network operating organization (EDUNET) or in the parent EDUCOM organization, if a lasting structure is to be erected. Certain functions are required for the design, operation, evaluation, and evolution of the kernel network itself. Some functions are rather readily implied by consideration of the context in which the kernel network is to operate; others are implied by the need to acquire materials for use on the network; still others are implied, more or less explicitly, by the needs of participating institutions for support of various kinds. Beyond those functions which appear to be minimally required are a number of possible functions whose appropriateness may be considerably less well established. The whole set of network-related functions suggested for EDUCOM is surprisingly large; not all suggestions made will necessarily be presented below.

First, a general statement of EDUNET functions:

1. Provide for more effective communication between the EDUCOM member universities and between persons within these universities.
2. Exploit all resources legally applicable to the attainment of EDUCOM goals.
3. Engage in mutually beneficial activities with NON-EDUCOM agencies and networks—which can contribute toward EDUCOM goals.

Several lists with greater differentiation of functions were prepared. A summary of some of the background and a partial list were provided:

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Adler
7/26

Of the several questions posed for answering by this group there were several which were combined under a classification of "EDUCOM's Responsibility." The specific questions asked were:

1. Where does EDUCOM's responsibility end and local responsibility begin?
2. Is EDUCOM responsible for systems software at nodal points?
3. Is EDUCOM responsible for program packages that are network related (e.g., shared file packages, others)?
4. Is EDUCOM responsible for software for applications of the network?
5. Should EDUCOM be responsible for keeping traffic records of who talked to whom and about what?

A first step in suggesting answers to these questions was to review the working papers and to record pertinent remarks made by others on these subjects. My quick review of the volumes of material may have missed some astute remarks, but I did uncover the following words of wisdom:

Taulbee, in his working paper "Management and Policy Considerations" made certain assumptions:

1. Services which the network provides are those which are either impossible or impractical for members to provide themselves.

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Adler
7/26
Cont.

2. The network is an information network, providing accessibility to information and data files in a centralized location. This is in contrast to a network providing only information on the availability of information and excess computer time.

Based on these assumptions, he suggested that EDUCOM establish and maintain the center (kernel) of the network and that member institutions retain responsibility for the establishment and control of terminal equipment and activities. EDUCOM would require adherence to certain standards for the interface so that terminal equipment and access codes could be provided compatibly by the member institutions. Also he suggested the possibility that an advisory committee be established to assist "have not" members in establishing their terminals. He assumed that the EDUCOM system would not be a free utility to user institutions and that EDUCOM would need to establish logging, billing, and accounting functions.

Taulbee suggested that EDUCOM must assume the responsibility for exercising control to prevent usurpation of the base network by one user or application.

John Carr, in his paper "A Proposed Functional Description of an EDUCOM System," stated that he felt that any decentralized portions of the facilities of EDUCOM should be under the direct control of the central organization, not of the local institution at which it might be located. He also assumed that the EDUCOM facility would be a communications switching and file searching device, cataloging information and facilities available at the member institutions.

Paul Davies suggested, in his working paper entitled "Relationships of EDUCOM to the Nonuniversity Community," that EDUCOM might assume responsibilities in these main areas:

1. Advisory—EDUCOM advises the institutions and funding agencies on how to contract for design, implementation, and operation of the network and of the information services provided over the network.
2. Supervisory—EDUCOM assumes financial and administrative responsibility for the design, implementation, and operation of the network and services; but others would actually perform the operations.

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Adler
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Cont.

3. Operating—EDUCOM performs most of the functions involved in operating the network and providing service.

Licklider agreed, in his response to James G. Miller's "Questions..." that EDUCOM should carry out the planning, construction, and primary operation of at least the initial experimental network.

Summarizing these responses and adding a few comments of my own produces the following answers to the questions posed above (using the same numbers):

1. It appears that EDUCOM should:
    a. Set standards for interface and software design;
    b. Maintain a central file of information available to member institutions. EDUCOM might not necessarily do more than copy the original and the updating information;
    c. Have a systems group responsible for the preparation, provision, and maintenance of software (and documentation) for utilization of the network and computer facilities by the network users;
    d. Make system recommendations to member institutions;
    e. Establish priorities or schedules for network use;
    f. Provide for inter-user communications facilities and expert advice on facilities or network design for member institutions;
    g. Provide manpower necessary to operate the network and hardware;
    h. Provide a staff of programmers, systems people, and analysts who would insure EDUCOM's systems approach to the fulfillment of its service requirements.
2. System software, i.e., software required to permit full access to and use of EDUCOM's network of facilities and information, should be provided by EDUCOM wherever it is required.
3. Program packages which are "network related" should be the responsibility of EDUCOM, if this means programs related to the operation of the network or those included in the central file. Other organizations may prepare these programs but EDUCOM must assume responsibility once they are made available to the network.

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Adler
7/26
Cont.

4. I do not think EDUCOM should be responsible for application software except to establish standards for format and documentation. EDUCOM should assume the responsibility for checking new programs (or other input) to be sure they are compatible with the system.
5. Certain traffic data should be maintained by EDUCOM for settling-up purposes. Funding agencies would probably require this information for auditing purposes. Who talks to whom for how long and what facilities were used seem important. My indoctrination in "Secrecy of Communications" leads me away from keeping track of what the transmission was about. EDUCOM should also keep track of and provide instantaneous information about the network status and availability.

A somewhat different list was prepared in another connection:

XXXI
Summary
7/26

We feel it cannot be emphasized too strongly that the EDUCOM grants must either provide funds for EDUNET professional staff members or alternate personnel from funded subcontracts who will perform the functions of:

1. Administration,
2. Establishing standards and system specifications,
3. Hardware evaluation, selection, and upgrading,
4. Software development and education,
5. Quality control with regard to input and the operating system,
6. General network operations, and
7. Systems research and development.

Further discussion of EDUCOM organization and function:

XXX
Kelsey
7/28

The following is a record of discussions of Group XXX, during the final week.

1. A user-group organization, advisory to EDUCOM, is recommended:
   a. Open to all substantial user institutions, as users concerned with services;
   b. The group may be as large as 100 or more individuals;
   c. Annual or semiannual assemblies are suggested of two or three days, well-planned with predefined issues, and with ad hoc subgroups as needed throughout the year.

XXX
Kelsey
7/28
Cont.

2. The training functions of EDUCOM are:
   a. To train people to use the network. Both university people, who would be involved in local nodes, and users can be trained in network use through an EDUCOM operated training facility;
   b. A four-to-six-day formal course (IBM model) for top level university administrators is recommended;
   c. Training is desirable in modern library skills to produce information specialists.
3. Long-range planning is essential as an EDUCOM staff function, to examine the probable needs and develop plans for 5 to 15 years ahead. It should be a substantial effort, i.e., five to ten full-time people, with subcontract funds and a rotating expert advisory committee. It should fully utilize the user-group assembly, search for new users, act as an R&D operating arm with full access to EDUCOM operations for experimentation, be protected against "fire-fighting" responsibilities both administratively and functionally, and correspond to a good corporate planning staff. Fiscal provision for such planning must be considered inseparable from fiscal support accepted for immediate mission-oriented functions.
4. "Fire-fighting" functions must be the immediate responsibility of the actual operations group, whether this be EDUCOM in-house or, more likely, a general contractor.
5. Development of communication system applications will be required as a part of the planning-applications-operations basic structure of EDUCOM. Applications development will be centered around clusters of user interests, such as:
   a. Improvement in library functions and operations,
   b. Health information handling,
   c. Continuing education,
   d. Computer operations,
   e. College instruction,
   f. University administration.
6. Standards and common practices need to be established. The intensity of effort here is dependent on the degree to which EDUCOM develops as a

XXX
Kelsey
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Cont.

network of information files with EDUCOM providing interuniversity access lines only, as against an EDUCOM-regulated series of files derived from all sources but reconstituted, once, for maximal utility and ease of access by all EDUCOM users. Formulation of working standards for the latter situations must be early, and with most careful attention to least cost (for easy access) for the greatest number of EDUCOM users. On the other hand, whenever EDUCOM merely permits one group to gain access to a second group's files, standards for the *core* (EDUCOM) processing are less controlling, since each university is to be responsible for translation of its standards and practices to the EDUCOM system. In either case, however, rapid formulation of principles and details for standards and practices *is most urgent*. Immediate funding should be obtained for a comprehensive effort in this area. Collaboration with existing groups (professional societies, etc.), can best be fostered if a more formal and regularized working relationship can be brought about between EDUCOM and the new NAS Scientific and Technical Information Committee (SATCOM).

7. In the EDUCOM organization, a subgroup should be formed to focus on data bank selection and acquisitions. This group must be expert in both subject matter and information processing technology, to assure that generally useful files are made easily available to all users.

It may also be of value to refer to the chart and list of negotiable functions quoted from Stewart (Figure 5-3). In consideration of the financing needs for the early stages preparatory to initiating experimental operations, it was proposed that:

XXXI
Miles
7/28

In order to proceed with the planning and implementation of the feasibility proposal, EDUCOM should immediately seek funds for an EDUNET staff nucleus with competence at least in the areas of:

1. General administration, financial and legal,
2. Network design,
3. Public and college relations.

XXXI
Miles
7/28
Cont.

> Our group estimates that a minimum of eight full-time equivalent professional and three clerical personnel would be required for the initial planning phase as follows: general administration—2; public and college relations—1; legal—1; network configuration group (hardware, software, standards, design)—4; and secretarial and clerical—3. It is estimated that by the middle of the second year of actual operation this type staff will need to be at least tripled and additional staff of considerable size added for the operational, maintenance, and software development requirement of the EDUNET.

The Group XVII Working Paper, however, produced another list of functions:

XVII
Taulbee
7/21

1. Administrative services (utilization, billing-accounting, contracting, etc.),
2. Government relations,
3. Professional society relations,
4. Relations with industry,
5. Member representations in governing council,
6. Standards,
7. Network facilities,
8. Network control and use,
9. Evaluation and planning,
10. R&D on network structuring,
11. Advisory function to "have not" members,
12. Legal services.

It may be instructive to summarize the functions listed above. Without regard to the implications of subcontracting engineering or software, it seems that EDUCOM must take a central responsibility in designing and operating a system which is to be capable of modification, enlargement, and development. EDUCOM must also arrange funding, from a variety of sources, for initial systems planning, at one extreme, to the phase where operations are sustainable on a mature basis; and it must be able to negotiate agreements for materials and services under an infinitely rich mix of circumstances. EDUNET must operate a kernel network which at least has referral and switching capabilities for subscriber access to information sources and resources, must maintain the files required for the associated directory or directories, and must generate the use records required for billing, for management purposes, and for evaluation purposes. EDUNET must also maintain a current users' manual in one or more forms to make available procedures for access to the system. EDUNET must also maintain a set of standards for hardware connection and message compatibility with the system, as well as a set of standards and operating procedures for files and programs which are to have community use. EDUNET must maintain its systems software and some necessary translation software. EDUCOM or EDUNET must provide for the acquisition and quality control of information resources to be added to the system. EDUCOM or EDUNET must provide for coordination of EDUNET with other information networks and programs for interchange either of materials or facilities. For all of the functions listed above, it will be necessary to provide adequate documentation.

The assumption of the functions listed above seems to be inescapable, if EDUNET is to have any meaningful existence. Some additional functions are almost inescapable: a strong supporting role in providing training and indoctrination for users; a strong role in promoting, if not actually taking responsibility for, program packages which may be broadly useful in certain families of applications; and some kind of role in facilitating applications developments. Some other suggestions may appear to be considerably more ambitious.

Once it becomes clear how many information files are required merely for operating and maintaining a "metainformation" system, it becomes tempting to add other files:

II
Licklider
7/9

> One of the most important functions of EDUCOM headquarters will be to gather information concerning the programs that could be incorporated into the network.
>
> The function of calculating enters into many, if not most, intellectual processes. Perhaps I should use a more imposing term such as "the application of the operations of logic and mathematics." To put those operations conveniently into the hands of creative people requires more than the mere provision of computer time. The advent of on-line interactive computing has made it evident to many that a much higher order of achievement in the generalization, documentation, indexing, and delivery of computer programs is both possible and essential. It is within the province of EDUNET, I think, to develop something that might be called an "On-line SHARE System." To do that for the whole field of computing would be too great an undertaking for an early project, but it would be appropriate and practical to undertake it for one or two selected fields, such as (since we are so near those subjects) computer-assisted teaching and learning.

Licklider continues to suggest other files that EDUCOM should operate (quoted on pp. 105-109) such as a file of network-related technical information, a file of on-going and proposed network activities (e.g., research activities using the network). He then discusses files of "public" computer programs and the records of use of the network itself as follows:

II
Licklider
7/9

> Another essential data base is the library of "public" computer programs. Oliver Selfridge has produced a working paper on the sharing of computer programs through a network (cf. pp. 135-138), and I subscribe to his statements. The suggestion here is simply that the development and operation of a system for storing computer programs (and subprograms) and making them available through the network should be formalized as a

II
Licklider
7/9
Cont.

definite EDUCOM project. Note that this project involves much more than the acquisition of a hardware file and the preparation of a software system for storing, retrieving, and disseminating programs. It involves a major effort in the formulation and testing of standards and conventions. Many groups and organizations other than universities must be involved in that effort, but it makes sense for EDUCOM—or whatever organization is first in the field with a coherent information network—to take the initiative.

The records of use of EDUNET will comprise an extensive file. The contents of this file will be of some interest to participant users of the network and of some interest to agencies that contribute to the support of the network, but it is not a file that should be maintained merely for occasional reference. It should be the focus of the evaluative study that will constitute one of the most important parts of the EDUCOM experiment. I envisage an organized study of network performance managed from EDUCOM headquarters but also involving groups in several universities. Early in this study, plans for monitoring and recording the most interesting aspects of network performance will be formulated. Programs to make the required observations and to channel the resulting information to the network of files, of records of performance, will then be prepared. Operational use of the monitoring and recording system will begin as soon as a significant body of records has been accumulated. The study will concern itself with assessment and evaluation, first of the system of monitoring and recording, and second of the performance of the network itself. There will be continual feedback from the study to improvement of the system for monitoring and recording. As soon as possible the study will begin to issue periodic summaries of network performance and to contribute to the technical literature of network design.

In connection with the training of network users the following point was made:

XIII
Hanson
7/18

It is hoped that the majority of systems and services in the network can be organized on a self-instructional basis. For example, the sequence of steps required to access and use a computer program would be output to

XIII
Hanson
7/18
Cont.

> the user during the calling procedure for the program. This would include such items as data formats, choice of program options, methods used, etc.
>
> Other ways of training users would include:
>
> Printed instructional material.
>
> Courses on an institutional level.
>
> Seminars or meetings on a network level on new developments, etc.
>
> CAL Courses via the network (i.e., a CAL programming course would satisfy a major requirement in the above example).
>
> Participation of EDUCOM in professional meetings.

Other EDUCOM information collection projects were proposed, such as inventories or facilities, curricula, etc., related to the network, files of new information technologies, and the operation of a clearinghouse for information on new educational media. Most of these would be subsumed under many of the suggestions of EDUCOM responsibility for technical advice to member institutions and research and development on their behalf in matters related to network operations. For example:

XXX
Miller
7/28

> Most universities have neither the power nor manpower to conduct unilateral research and development on sophisticated networks of the future, nor do they have the contacts or mandate to represent other universities in such functions. However, some representative and approved organization will have to provide this service in the near future. This obviously should be an organization which closely relates and is responsive to leading universities and higher education in general. It should be recognized nationally as the single entity which represents higher education in both government and financial circles for the research, development, and control of additional educational systems which may in time be able to communicate directly with the general public.

XXIII
Woodbury
7/25

> The existence of an effective network will inevitably attract far more use of the system than can be met. A major danger will be the tendency of movement of skilled operational and research persons to the group responsible

XXIII
Woodbury
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Cont.

for operations from the group responsible for the exploration of new techniques and research. Continual evolution of techniques is a necessity. There must be a firm policy that a fixed proportion of the available resources are devoted to R&D.

In connection with technical support to institutions:

XIV
Seibert
7/20

It has already been indicated that personnel from EDUCOM should be available, as consultants, to assist participating institutions in becoming compatible with the kernel network. Also, in a related paper, it has been indicated that EDUCOM should undertake to provide educational programs and counseling to the faculties and staffs of participating institutions who desire to make better use of the EDUCOM services. These last seem especially important, if EDUCOM is to achieve the level of service of which it is capable.

It is obvious enough that faculty members are not uniformly aware of many long-standing services available to them through their own local libraries or audio-visual centers, professional organizations, etc. They will almost certainly be equally ignorant of the various services which EDUCOM might provide and elaborate provisions are probably required to disseminate this information. It should be mentioned, too, that faculty mobility makes this dissemination task a never-ending one; without special and continuing efforts on the part of EDUCOM, there will be a new crop of blissfully ignorant faculty each year.

In connection with standards:

V
Summary
7/7

EDUCOM and the universities must consider the American Standards Association activities on information processing systems and determine what form of representation if any should be made on the working subcommittees.

and in connection with quality of information:

XXI
Drew
7/22

If good information is diluted with trivia and inaccurate data, it becomes almost useless. A case in fact of this nature is the SHARE library. The situation could be controlled as though there were a Journal of EDUCOM. One would submit an entry to this "journal," and it would be reviewed in the same manner as a paper submitted to any journal.

On several occasions observations were made about the importance of libraries to EDUCOM as well as to their users. A particularly strong statement was made urging EDUCOM involvement. Perhaps similar statements could have been produced about computing centers, audio-visual centers, and educational broadcasting. In connection with libraries it was proposed that EDUCOM should:

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Cheshier
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1. Organize a summer study similar to this one to consider the problems and suggested solutions and come up with a better set of both. Issue a report of the conference recommendations to universities regarding the solution of their library problems.
2. Establish a roster of existing and proposed training programs, together with a critical evaluation. Consider the suitability of EDUCOM fellowships to send persons to these programs for training. If this approach is desirable, secure the necessary funds from member universities, federal agencies, and industry. Substantial participation from all three sources is regarded as essential in view of the benefits to all parties.
3. Institute a study of existing and potential library user population. This will require the participation of persons from many fields, e.g., statistics, library science, psychology, and education, to name a few.

Many of the activities called for, such as research and development on network facilities, design and operation, technical support to participants, applications packages, development of standards, etc., would seem to go well with an EDUCOM Information Center. Such a proposal was made, suggesting:

IV
Summary
7/18

An EDUCOM Information Center, to collect and provide information on, for example, equipment, evaluation techniques, network problem exchange, directories of staff and courses.

At various times during the Summer Study, suggestions were offered about miscellaneous activities in which EDUCOM might engage, ranging from research projects on the processes of higher education to sponsoring national meetings of various kinds of professional groups. When the already large scope of activities for EDUCOM and EDUNET is contemplated, it appears that such activities ought not to be undertaken with primary responsibility within EDUCOM; in these matters it might be appropriate to confine EDUCOM's roles to cooperation and stimulation.

Perhaps this section may be closed fittingly with EDUNET and EDUCOM organization charts produced at one point during the study, not necessarily reflecting later deliberations:

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Woodbury

The accompanying charts are not so much organizational charts as a functional breakdown of EDUCOM and EDUNET components, not all of which are located at any one geographical location or within any single organizational component. The three broad areas of EDUNET are related to the management of all facilities needed at the nodes and lines of the network and the functions served by the lines and nodes respectively.

The persons involved in these functions should be technically competent professionals whose time and attention are mostly allocated to insuring the efficient operations of the network. It is assumed that most organizational functions unrelated to these are performed elsewhere in EDUCOM components probably already defined by the Task Force structure.

The relations of these application groups to EDUNET remain to be explored for their organizational implications.

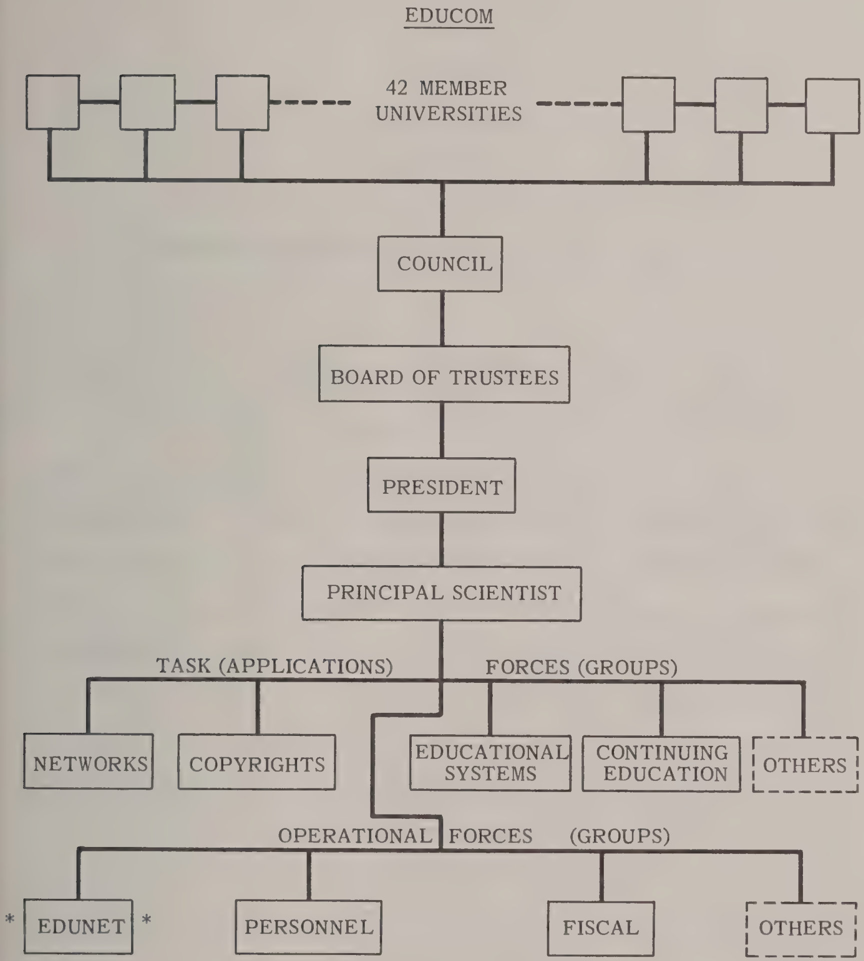

Figure 5-4. A Functional Diagram for EDUCOM

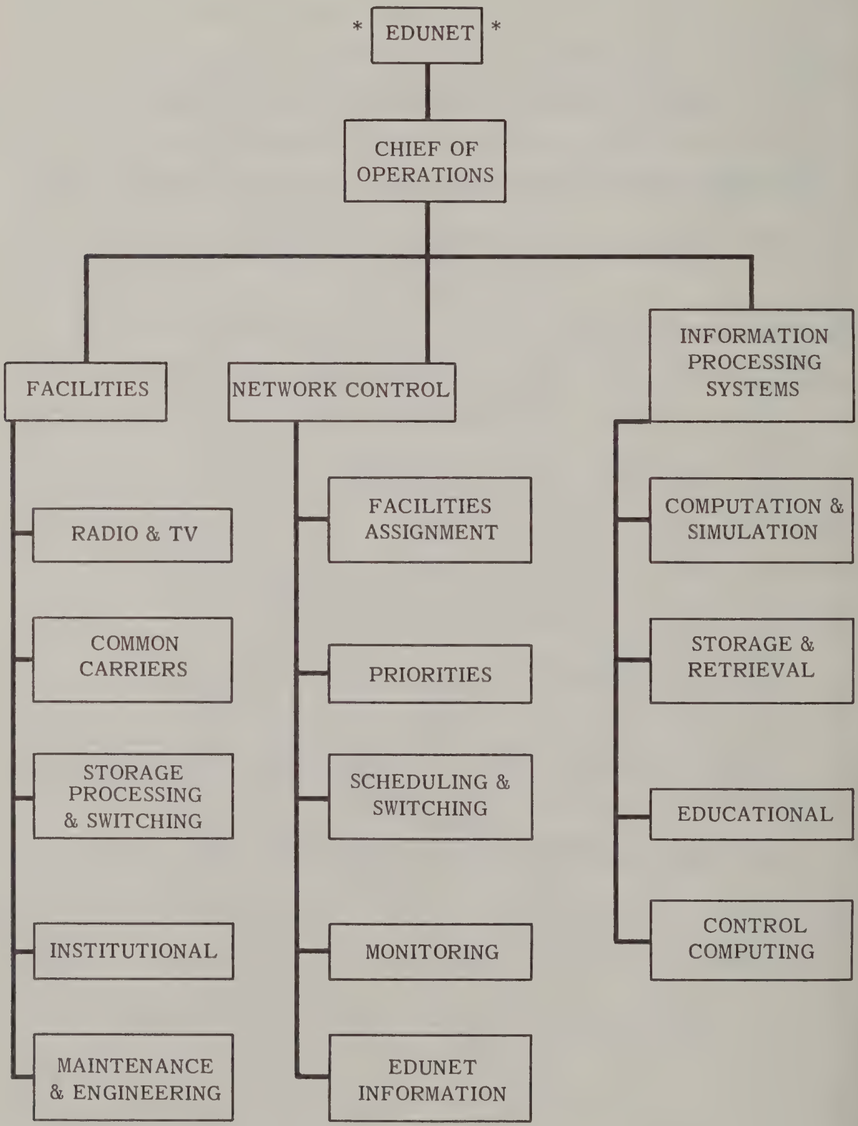

Figure 5-5. A Functional Diagram for the Operational Force—"EDUNET"

6

Network Design

I. CHAPTER SUMMARY

This chapter deals with the problems that need to be solved and considerations that need to be taken into account in the design of EDUNET. No attempt has been made to devise a detailed technical design. This can only be accomplished by a highly skilled and experienced group of designers. We do not consider the present lack of a "nuts and bolts" design to represent any failure of the Summer Study. It is much more important, at this stage of development, and perhaps much more difficult, to analyze and understand the many considerations that must finally determine the design.

The first determining consideration is the scope of the network. This, in turn, is determined by topics (considered in the preceding chapter) such as: who is the network to serve, what services are to be expected, what use of existing centers and networks is to be made, and what rate of development is required. Arguments have been made in favor of an initial limitation to some geographic area and to certain selected applications. However, the consensus that clearly emerged from the Summer Study was that EDUNET should become a nationwide network as soon as possible and to do this it is appropriate to make full use of existing networks.

We next examine effects of software requirements on the system design. It is evident that the network, with its public and private information facilities, must be protected from inadvertent sabotage. Protection can be provided partially by hardware associated with files and transmission terminals, partially by rules and procedures governing access to software, and finally by operating supervisors aided by displays of the status of and priority access to the system components via the network. Specification and development of the system software is likely to be a more expensive and time consuming task than specification of the hardware. One estimate, in a plea to keep the software as simple as possible, gives nine man-years as the effort to implement such a minimum software system.

The next consideration is that of the technology available to implement the network. The situation is well summarized, at least with respect to the hardware, by the quotation—"None of the demands of an EDUCOM network are beyond the capability of our technology, although some of them will require new combinations of existing technologies." That the situation is less clear for the technology of software systems is illustrated by an account of the problems of handling bibliographic data. The comparatively undeveloped state of software technology is undoubtedly just a reflection of the brief history, and thus the limited accumulated experience, of this field.

Two alternative designs were proposed during this study.

These designs are presented and analyzed in section V of the chapter. The major difference seems to be in whether the control facilities and directories are centralized or decentralized. Evidently, there are certain logical and technical advantages to a decentralized design.

Finally, cost estimates were made on the basis of two sets of assumptions which include arbitrary, but educated, guesses as to the geographic location of facilities and the required channel capacities. The significance of these estimates lies in suggesting the order of magnitude of the cost associated with specific communications capabilities.

The chapter closes with a brief evaluation.

II. THE SCOPE OF THE NETWORK

Engineering design normally proceeds through a set of stages, frequently in parallel, loosely characterized by the following terms: requirements, available technology and parameters, proposed designs, and design evaluation. This device will serve as the organizing principle for discussing the design, not of the whole system comprising EDUNET (with associated elements of EDUCOM, users, institutions, and the protocols which relate them), but rather of the major element so far avoided, namely the communications system and elements closely related to it. The preceding chapters of this report have dealt primarily with other aspects of the system, under the assumption that appropriate communications would be available. It may be that some individuals, having now seen the implications for EDUNET organization, will be prepared to assign less relative weight to the difficulty of providing communications than might have been the case a priori.

Requirements. Before narrowing the discussion, it may be pertinent to include here a suggested outline of the contents of a network proposal:

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PROPOSAL FOR AN EDUCOM NETWORK

I. Introduction
   A. Needs to be served:
      1. Bulk communication (lots of it, cheap, and cost included in overhead);
      2. Well planned system for service and growth.
   B. Capability of proposed network:
      1. Communication services (teletype, CRT or voice, tape transfer at high rate, video-audio);
      2. Information services (access to member services, storage, directory, monitoring, switching).
   C. Benefits anticipated:
      Improved efficiency and effectiveness in teaching, research, administration, services to government, industry, professions, and the public.
   D. Time schedule:
      Completing proposal including arrangements with initial participants, funding, and initiating network operations.

II. Network use by type of application
   A. Bibliographical service—interrogation and retrieval of established files;
   B. Building automated files by groups on network;
   C. Computer-aided learning—development, research and demonstration, and teaching with specialized groups;
   D. Interchange use of computer programs (on-line directory of programs available, emphasis placed on built-in instruction on how to use programs and assimilation of users' comment file);
   E. On-line debugging and computation;
   F. Data transfer (e.g., magnetic tape, telemetering, machine-machine);
   G. Two-way communications, person to person;
      1. Message,
      2. Voice,
      3. Audio-video.

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Cont.

III. Other ways of viewing use of network
   A. National goals—mission:
      1. Health,
      2. Education,
      3. Economic growth,
      4. Defense.
   B. People to be served—described by roles:
      1. Student,
      2. Instructor (and teaching assistant),
      3. Author for instruction,
      4. Scholar-researcher,
      5. Practitioner,
      6. Academic administrator,
      7. Facilities administrator,
      8. Public.
   C. Disciplines:
      1. Physical sciences and engineering,
      2. Biological sciences,
      3. Social sciences,
      4. Humanities.

IV. Selected examples of network usage

The proposal should include 20 or more examples demonstrating initial network usage by individuals committed to use the network.

V. Proposed structure of initial network—physical facilities
   A. Centers of population and of education-research connected by network;
   B. Communications and terminal equipment made available to user;
   C. Central services provided;
   D. Provision for expansion.

VI. Operating and management contributions for EDUNET
   A. Operational characteristics to be achieved
   B. Organization chart:
      1. Management of facilities,
      2. Network control,
      3. Information services.
   C. Policy matters allowed for in foregoing structure:
      1. Responsibilities of participating organizations,

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Cont.

    2. Establishment of priorities and followup procedures for equitable access,
    3. Standard practices.
  D. Implementation:
    1. Standing committees,
    2. Pilot operation of central network facilities on short lines,
    3. Final specification and start-up.
  E. Technical supporting services and other community services

VII. Time schedule
  A. NOTE TO EDUCOM STAFF: What needs to be done, and the time required to finish the proposal.
  B. Discussions among EDUCOM members:
    1. For coordinating technical patterns,
    2. Relationship between network and initial participants.
  C. Preliminary discussions with potential funding agencies.
  D. Budget determination:
    1. Staff,
    2. Network communication services,
    3. Support of activities.

The functional description proposed by Carr and the related material cited at the beginning of the preceding chapter serve to define the context for the communications system as well. Specific requirements seem to have been generated for data, voice, and image transmission, for system expandibility, for store-and-forward capability, for interactive capability, for interface hardware and software, etc. Closely related to the central conception of the kernel network is the directory system, whose characteristics were described earlier in the extract from Taylor (see pp. 102-104).

Requirements for relationships with other networks have been referred to previously, but the following presentation argues specifically for interconnection with "subsidiary" networks, with implications for the network structure.

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It appears at this time that the initial EDUCOM network will be limited in its (1) number of nodes, (2) central storage capacity, (3) access to existing data bases and (4) transmission capability. The initially established network will provide more information for more users if it ties together a number of subsidiary networks. Some of these are in existence. Others are in various stages of development. As the kernel network increases in size and complexity, such subsidiary networks will continue to add to the utility of the kernel network and enable its services to be made available to an ever-widening community of users. Further, it is likely that this encouragement of the development of subsidiary networks will result in significant savings in operating costs for the network and its components.

Initial stages of the kernel network

At this time it appears that five to fifteen nodes are the maximum that can be accommodated initially. This means that more than half of the EDUCOM member institutions will not have nodes on the kernel network. If it is necessary to provide nodes at data sources that are not member institutions, initial participation of member institutions will be further limited. Many of the member institutions will have difficulty maintaining enthusiasm for EDUCOM if they have no access to the network.

If the system were designed to permit geographical groupings of EDUCOM institutions into subsidiary networks, with one member institution having a node to which the remaining member institutions have access through the subsidiary net, the initial impact of EDUCOM on its member institutions would be heightened and their initial enthusiasm more easily retained.

Later stages of EDUCOM development

As EDUCOM grows, all member institutions will have nodes, more data bases will be made available, new services and transmission facilities will be added, and EDUCOM membership will become more attractive.

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Throughout this stage, institutions can begin their EDUCOM participation as nodes on subsidiary networks, moving on to full network participation when feasible. Smaller or "have not" institutions may have access to EDUCOM facilities and resources through participation in subsidiary networks.

Advantages in subsidiary networks

Initial participation in EDUCOM by all member institutions is possible only through subsidiary networks. Prospective member institutions can begin EDUCOM participation in subsidiary networks. Institutional experience in such networks will be of great value in preparing for full participation in the kernel net (i.e., debugging programs and equipment, solving systems problems, training personnel). On the other hand, experience gained with subnetworks will be of value to the kernel network. Smaller institutions with limited resources (fiscal and data) can realize EDUCOM benefits without full network participation. There will be savings for EDUCOM, member institutions, and other user institutions in this concept. Further, a substantial percentage of some kinds of needs (i.e., libraries) may be answered within the subnetwork, thus decreasing the traffic on the kernel network.

Some aspects of operation

Some subnetworks now exist, others are needed. EDUCOM should encourage and, in some cases, initiate their development. A sub-task-force would be helpful here in suggesting standards. Some of these may begin operation before the kernel net goes on-line.

Subsidiary nets should be centered upon a kernel network node. They will be on-line with the network node which, in turn, is on-line within the kernel network. They should be interconnected by voice grade and data transmission lines with the capability of voice communication and data and image transmission. The data and image communication capability may not need to be duplex, and conversational mode may be unnecessary, at least for institutions lacking sophisticated terminal and computing equipment. Incidentally, institutions with

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Cont.

substantial and highly useful mechanized data files will almost certainly need to have nodes on the kernel network.

Some applications

Knowledge of availability and actual interchange of library materials is one area of application appropriate to subnetworks. A group of university and college libraries in a state or region could agree among themselves to install TWX and facsimile terminals, cooperate in developing directories of their resources, agree to allow each other maximum possible use of each others library resources, and begin the exchange of information. An EDUCOM node in the area would provide the group with access to the larger system with appropriate queuing arrangements and provide guidance and coordination for the group.

Such subnetworks can also provide member institutions with computation time, access to small data bases, regional lecture and instruction programs, and other possible applications.

Conclusion

Local, state, and regional subsidiary networks, centered on EDUCOM nodes have a significant role to play in helping EDUCOM to achieve its objectives. They offer an economical way to extend the benefits of cooperation in making knowledge available to the national educational community. They may be as important in achieving EDUCOM's goals as the kernel network itself.

Also related to the distribution of participants:

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It is recommended, then, that in the choice of participants the size of the institutions to be served be considered and that a substantial fraction, both initially and later, be universities or colleges of relatively small size. Second, it seems desirable, if not absolutely essential, that the connected institutions range geographically from the east coast to the west. Achieving this early should make it easier to expand in later stages, for both technical and nontechnical reasons. Third, as already suggested, an implied consideration in the choice

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should be the extent to which the inclusion of a given university would broaden EDUCOM's services into disciplines outside the "hard" sciences and medicine, into instructional and administrative or service areas, and into the use of hardware other than computers.

and

II
Licklider
7/8

In my concept, the EDUCOM network is a network of networks. Some of the subordinate networks have relatively fixed links that are owned or leased by EDUCOM. (By saying "fixed," I do not mean to imply that they are not switchable; I mean only that the wires or cables or microwave towers stay in position from month to month.) Other subordinate networks use more-or-less ordinary services of the telephone-telegraph industry, relying upon the industry for switching as well as for the wire, cable, etc. During the first years of operation, the economic advantage of geographical proximity will be very great for the first kind of network, less great and perhaps not even a dominating factor for the second kind. It seems important to me that there be at least some facilities for linking universities coast-to-coast. In several fields, the most effective working units include people from diverse parts of the country, and it would impair rather than facilitate activities if nationwide working units were fractionated into regional segments.

III. SOME SOFTWARE REQUIREMENTS

Translation interfaces have some pertinence to the discussion. The following argument apparently applies to nodes which look toward and away from the kernel network.

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Assuming the network is composed of nonhomogeneous nodes, at least some of which already exist at the initial operational stages, the problem here is to determine that standards of operation and format are established, so that access among the nodes is meaningful and, if possible, reasonably simple and rapid.

There are essentially three alternatives to the problem of communication between nonhomogeneous nodes. One is the assumption that all nodes will maintain their local standards. Any node wishing to communicate with

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a foreign node would need a routine to convert incoming responses from the form of the foreign node to its local format. Thus in a network of n nonhomogeneous nodes, each node may need (n - 1) conversion routines plus all the control mechanisms needed to determine which routine is needed for a given transmission.

The second alternative is the establishment by the network controlling body of universal standards to which all nodes must conform. Thus a message arriving at or leaving any node would appear identical, requiring two (or more) routines (unless the local standard was the universal standard) at each node to convert between the standard and local. There would probably have to be more than one standard (e.g., ASCII for messages, a standard for boundary conditions to routines, and a standard for requesting of execution and storage facilities on other nodes).

The third alternative consists of a black box (kernel computer) which would perform all local-local conversions.

The advantage of the first alternative is the ability of all local installations to maintain their existing routines and files with little modification. The difficulty, of course, is the requirement for a large, and probably increasing, number of conversion routines at each site.

The first advantage of the second alternative is the relatively few routines needed at each node. The second, and possibly, bigger advantage, is the development of standards which may in the long run foster an increasingly homogeneous network. (There are advantages to be gained by adhering to the standard at each node.) The main problem here is that of setting acceptable standards in areas where little previous work has been done.

The advantage of the third method is the easy entrance into the network by any new node. The expense of the central converter and the lack of any standard seem to be serious drawbacks with this scheme.

Alternative two seems to be the most desirable. It is a reasonable compromise in getting started and holds most promise for the long range.

Software which exists on the network (outside of executive routines) can be classified as public or private. Private software is that whose access is limited to an individual (usually the originator) who has complete control over its disposition (e.g., rights to modify, destroy,

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or relinquish the incidents of ownership). He pays for the right to produce, run, and store these files. In turn, the local systems protect its integrity in the way he desires.

The second class of software is public. Incidents of ownership of this software belong to the network administration, who in turn "compensate" the individual who has provided the software. In order for software to become public, certain conditions must be fulfilled. It must be adequately documented, and the network management must verify that the operation conforms with the specifications. It is proposed that any authorized user have ready access to the public files and the privilege of their use.

It seems as though there may also be a need for a type of public file which permits the originator to maintain the right to modify it (for experimentation purposes, for example). In this case, the documentation as well as the contract between the originator and the network administration would have to state this clearly. This type of file should be the exception rather than the rule.

In a network where all centers are essentially equal, the protection of any file rests in each local center just as it does in a stand-alone time-sharing system. If a file is labelled public, the local system must assure that there be no unauthorized modification of the file. This could be done by causing error traps to occur when unauthorized access is requested. If a file is private or restricted to a limited (local) set of users, the local center must verify the user's identification and give him access only if authorized. Of course, complete incidents of ownership are available to originators of private files. No one other than the originator would be allowed to delete private files from the system.

The dichotomy between public and private files as well as the various modes of protection for private files (e.g., read, write, execute) serves as a satisfactory means for preservation of integrity.

On approximately the same topic, the following analysis was produced later.

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Alexander has described two possible network "pickups," one of which terminates in a small console and the other, in what is in itself a large facility, perhaps a

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university computing center. The purpose of this paper is to discuss some issues connected with the responsibility for the software at such terminals insofar as it influences the network.

Consider the first type of terminal. Although it is small, it has some data processing capabilities, probably particularly related to the identification of information (both an absolute "what are these data?" type of identification and in an "end of record" sense). For instance, such a terminal might have the capabilities of identifying the information sent, the destination, and the implied disposition at the receiving station. In some applications, local on-line consoles and computers might be used to edit and format messages eventually destined for the EDUCOM system. Data format conversion and reblocking are also typical applications of such a small terminal in connection with the network. The terminal might have the capability of interrupting some network lines to request permission to send a call for system attention. At the very least a small terminal must be able to "call" a line, thereby entering some sort of queue. In any network, the terminal can affect the performance of the network. Under some conditions a terminal might be capable of doing considerable damage to the network.

Is it reasonable that in the case of such a small terminal the software be supplied or approved by EDUCOM? Let us not forget the administrative and procedural problems which would be involved if terminals at remote locations (and therefore to some extent physically controlled by the user) were required to use only software approved by EDUCOM. Would the purposes of the system best be served if such restrictions were imposed? Would this restriction be a practical one for small terminal users?

The advantages of such restrictions for smooth and predictable operation of the network are obvious. But, of course, an EDUCOM systems group would have to write software for a large variety of terminals, or, at a minimum, specify segments of the programs for these devices and approve the programs implementing those specifications.

Two extremes of small terminal user profile will be compared.

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One type of user is typified by some (but not all) applications in the process control industry. This is a user who does not know or care about the programs in the computer. He has a frequently used set of applications, or a single application, which might involve the gathering of data and outputs to equipment. This type of user is not about to modify the software of the system; he uses one set of programs again and again.

Suppose a user of the EDUCOM system with a small local processing device is in a situation in which the device is dedicated to the sort of work described above. Then there is no reason why, from the user's point of view, EDUCOM cannot exercise control over the software. The word "dedicated" is employed because there is just one task for which the terminal is used. However, he may not need the computer for three shifts per day, in which case it becomes available (excluding extreme security) to others. Frequently, a happy characteristic of academic institutions is an ability to "make do," and as soon as a secondary (in the original plan of things) user finds that he can make use of a system for some function other than that for which the local (and supporting system) software was originally designed, the system becomes nondedicated.

The point is, dedicated terminals will remain dedicated only if either (1) all nondedicated uses, potentially beneficial or not, are eliminated, along with any potential value that they may have, by strict regulation of the use of the terminal or (2) the workload of dedicated processing occupies all of the available terminal time so that there is no time for nondedicated use. Point (1) involves a value judgment which may have considerable legal and economic overtones: "May, indeed, this equipment be used for unexpected types of work in light of the conditions of its acquisition?" For example, very legitimate uses not necessarily related to the supposed ones may arise after a system planned for dedicated use has been installed. So with the exceptions listed, small stored-program remote stations may be used for a variety of changing applications, regardless of the original intent at the time of their installation.

It is clear that, in the case of a truly and permanently dedicated device, machines may be supplied with invariant EDUCOM-written or approved programs, with no limitation on their utility.

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Consider a terminal not originally dedicated in the sense above. Assuming that the terminal is used for various purposes, both in connection with EDUCOM and independent of it, the programs (and in many applications, elements of the equipment) are subject to change. Most lightweight computers do not have provision for memory protection, and so, even EDUCOM-authorized software packages may accidentally be alerted. Further, in many applications of such computers, a major element of the programming task is in the input/output area. So, the job of generating software or approving it for the sensitive areas is a large one. Unless small terminal users are forced to adopt similar equipment, EDUCOM will be faced with an enormous programming load; and, even then, if user problems destroy the approved network programs, the terminal may still send incorrect signals into the network.

Unless the EDUCOM network is to be restricted to the dedicated small terminal user, it must be able to protect itself from the user who inadvertently sends signals into the network. Approved software for the sensitive areas of all of the different small terminals would be costly and still not perfect in protection. Instead, the network (that is all of it outside of the small processing unit in question) should be able to protect itself against abuses arising from small nondedicated installations in which errors have been made in the local system's programming. The network itself should be able to reject any illegal signals sent by a small terminal, and also warn any communicating stations that a possible loss of information has occurred.

Summarizing for the small dedicated terminal, EDUCOM might very well be able to supply or approve software for use in potential trouble areas. For nondedicated small terminals, EDUCOM might have a very large task in supplying all sensitive programs, and even then bugs might creep in owing to the varied use of the terminals and changing nonsensitive (but still potentially dangerous) programs. So perhaps the best solution is to allow user responsibility for software at such nondedicated terminals, while specifying techniques and aiding user programers; this should be combined with network monitoring of such terminals.

The large computer center is by nature nondedicated. It processes many different types of problems, but in

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some sense its communication with the network may be more restricted than the linkage of the small unit. This is true because, in contrast to a small shop, much more control may be exerted over those responsible for the programming and operation of the system at a well run installation, the primary business of which is data processing. The network communication routines can be controlled, and changes in them negotiated with EDUCOM. The manager of such an installation understands and appreciates the damage that faulty communications with network might bring. From an administrative point of view, he is in a much larger sense aware of network relationships than the sometime user of a small system. He can arrange for the simulation of network-related problems before their production use. And so, it may be possible for an EDUCOM computer communications network to operate even when the larger terminals do have the power to disrupt the system—because of higher confidence in the operation of those large terminals.

So in one aspect such larger terminals may be treated as dedicated ones, since their network communication facilities may (from a programming systems standpoint) be isolated from other functions.

The following analysis of network operation by supervisory personnel has implications for the system design and imposes further requirements on the communications system itself:

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This working paper discusses the day-to-day operation of the EDUCOM network and the procedures required to assure continuous reliable operation over extended intervals and rapid recovery from either local, kernel, or total system malfunction. The assumed network configuration consists of a central *communications system* that interconnects terminal equipments at participating centers through buffer/translator interfaces connected to *nodes* of the communication system. A local malfunction may occur in any equipment either in a center or in an interface, at a node or in a communication channel.

The *kernel* of the network is the central equipment common to the network as a whole and is assumed here to include the communication system, the nodes, and

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some portion of the interfaces; the exact point of demarcation within the interfaces need not be delimited for the purposes of this working paper. Note that there is an implicit assumption hidden in the above, namely, that the centers have some kind of authority or ownership over their computer complexes and related equipments whereas some other network agency or holding group exercises authority or ownership over the kernel, i.e., everything else.

Day-to-day operation of the network requires that rules be established for orderly shared use of the equipment and that these rules be agreed upon and adhered to by all participating centers and by the network management. The term management refers here to the owners or operators of the kernel who may provide other services such as accounting, invoicing, directory, and other network-wide information handling to the centers and who may exercise certain authority over the centers and have certain prerogatives in connection with overall network control.

The following requirements enter into the establishment of network operating rules:

1. Procedures are needed for maintaining normal (i.e., mutually agreed upon) operating conditions of terminal equipment at each center, and hence, for displaying each center's operational status on status boards at all participating centers that provide service. Such displays must provide supervisory personnel with up-to-the-minute information on the instantaneous condition of network availability, including consoles, peripheral devices, and other local equipment. Similar procedures must provide status displays for interfaces and communications channels. Note in particular that harmonious, efficient use of the network demands cooperative advance scheduling of equipment use, i.e., a reservation system must be developed.

2. Cooperative advance scheduling of equipment maintenance is needed with special reference to the time-shared hardware-software computer complexes and the individual components thereof, including their interfaces.

3. Procedures are needed for rapid recovery from malfunctions of all sorts, including the failure of one or more terminal devices, one or more communications

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channels, software in one or more computers, or any combination of equipment up to and including total system breakdown.

The operating rules must take into account the evolution of the network both through expansion of capabilities at one or more centers and through connection of new centers into the network. Special rules may have to be adopted during initial implementation, not only because of the rapid evolution that may occur but also because of the limited experience that will be available.

A significant portion of day-to-day operational activity of supervisory personnel will be concerned with instruction, supervision, and monitoring the use of consoles. Bad console practice is not only frustrating to the user but also hazardous to the network. Responsibility for network malfunction due to console abuse should presumably rest with the local center whose supervisory personnel should prevent its occurrence.

Day-to-day operation requires frequent direct contact among supervisors at various centers. Much of this contact can be programmed into the system and achieved through tele-typewriters or TV communication. It is likely that many telephone contacts per day will be needed to maintain orderly network operation; telephone facilities for the purpose should certainly be maintained, particularly since such facilities are essential in the event of center-to-center malfunction over the network communications system.

Day-to-day operating procedures will call for connect and disconnect switching of individual devices, such as magnetic tape handlers or line printers. Other switch settings will serve to establish monitoring modes for both on-line service and later diagnosis. There are occasions when the operating mode of the computer complex at a center may need to be altered through a switch setting; such action is occasionally taken in existing installations but it should be discouraged in the EDUCOM network because of the confusion that can result in a large system of cooperating centers.

The next item indicates the combinations of various modes of communication and users' intent for which procedures will be required.

XXVI Drew 7/27 A prospective user of an EDUCOM system will first have to determine which of several modes of communication will best suit his needs. These include, for example:

1. Voice,
2. Video,
3. Keyboard/Printer,
4. Facsimile.

He will then have to employ the procedure of the system for the specific type of use he intends to make of the selected mode of communication. These types of uses include:

1. Making a contribution for EDUCOM use,
2. Transmitting a document,
3. Participating in a conference,
4. Transmitting a presentation,
5. Performing a search,
6. Using a time-shared computer,
7. Transmitting data from storage to storage.

It will be possible to write procedures for many of the various combinations of communication modes and types of uses. Therefore, it will ordinarily be possible for a user to communicate in a routine manner once the procedures have been established. The exceptional cases must be handled on an individual basis using EDUCOM consultants to set up the required procedure.

In the face of all of the requirements which have been put on communications software there may be some difficulty in reconciling the multiplicity of functions proposed with the caution expressed below. No doubt similar ambivalences exist in other areas of the proposed network.

XXVI Drew 7/28 The exact nature of the requirements of the EDUCOM system will be determined through its use. Because of this, it is impossible to design a final software system adequately. Thus, the initial software must be minimal and should evolve as more experience in the system is gained. Therefore, it can be concluded that the initial software should be limited to communications functions and record keeping and that even these should be kept as simple as possible.

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If the initial software is minimal, it can be implemented in a reasonable time at a modest cost, say nine man-years. It will also be relatively easy to change or replace with a more sophisticated package at a later time.

IV. AVAILABLE TECHNOLOGY AND PARAMETERS

The capacity per unit time of a communications channel is measured by bandwidth. Input and output devices, with speed characteristics of their own, may have bandwidth requirements or may impose limits on the useful bandwidth attainable in a channel to which they are directly connected. Table 6-1 shows the relationship between various kinds of input-output devices and general types of communications channels.

The following analysis is of particular interest because it relates specific items to be communicated to the channel durations required. Note that requirements for voice communication, considered important for many applications, would presumably use the same channels as communications required for switching and control. Further, the assumption that traffic clears in 24 hours may be in conflict with the needs for interactive communication, coupled with considerations of load variation.

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To date at this Study I have listened in vain for some quantitative rationalization of channel requirements for the EDUCOM network. While Telpak A, B, and C channels have been referred to, no one has shown (as far as I could determine) how such requirements were generated.

I will take a crack at estimating requirements. While some of the data generated are by-and-large sufficiently accurate (i.e., time and bandwidth required to transmit a page of written material), other data (such as total channel needs) will be very rough guesses—based on an

Table 6-1. Classification of some principal source information input/output devices and the common carrier network(s) they commonly utilize

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	NETWORK			
	Narrow Band (150-300 CPS)	Voice Band (4KC)	Broad Band (48 KC - 1 MC)	Video (to 6 MC)
A. Alphanumeric data:				
Teletypewriters send & receive	X			
High speed printers		X		
Punched cards		X		
Punched tape	X	X	X	
Magnetic tape			X	
Cathode ray display tubes		X		X
Facsimile		X	X	
B. "Static" graphic data:				
Electro-writers		X		
Cathode ray display tubes		X		X
Facsimile		X	X	
C. "Telemetry" data:				
Sense/control devices	X	X	X	X
D. Dynamic graphic data:				
EKG, other analog devices		X		
Television				X
E. Voice				
Telephone		X		

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intuitive feel from a narrow and insecure base. Nevertheless, the overall conclusions have value in that as better indications of users' requirements (number of users, pages per use per day to be transmitted, etc.) are established, they can be cranked into my approach to generate more reliable answers.

Table 6-2 gives a summary of times required to transmit a page of material in various forms by means of Telpak A. The assumptions and supporting calculations are given on the following pages.

Table 6-2. Summary of Times Required in Telpak A Transmission

Typed page	0.5 second
High resolution photo (1000 lines/inch)	2.2 hours (digital) 1/3 hour (analog)
Low resolution facsimile (100 lines/inch)	1.3 minutes (digital) 12 seconds (analog)
Low resolution black-white facsimile (100 lines/inch)	18 seconds (digital) 12 seconds (analog)

Now, getting to an area of pure conjecture, but hopefully helpful as a rough first cut, I will make an estimate of the channel requirements to handle an EDUCOM network of 200 institutions. Voice and TV requirements are not considered.

Assumptions:

1. 200 universities (identical)
2. Each university will handle (duplex):
   a. 100 requests a day, involving an average of 10 typed pages;
   b. One request a day for a high resolution photo;
   c. Ten requests a day for a low resolution facsimile;
   d. Ten requests a day for a low resolution black-white facsimile.

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Hence, each university will handle (duplex):

Typed data, 1000 pages	= 500 seconds
High resolution photo, 1 photo	= 1200 seconds
Low resolution facsimile, 10 pieces	= 120 seconds
Low resolution black and white facsimile, 10 pieces	= 120 seconds
	1940 seconds of Telpak A per day

200 universities would use a total of 388,000 seconds of Telpak A per day which is equivalent to 4.5 Telpak A channels full time (24 hr/day). Not included in this estimate are times for switching, message headers, voice or TV service.

If all of this traffic were routed through a single pipe, a Telpak C channel would be required. This will most likely never happen (based on the traffic assumptions made above). Spur trunks to regional groups of 25 universities and 50 universities would be satisfied by one-half and full Telpak A service respectively. Backbone trunks which carry not only traffic generated by their associated regional groups, but also through traffic from distant regional groups would require Telpak A or Telpak B service.

The further assumption is made that the system is store and forward (both analog and digital) with sufficient capacity to clear a day's traffic over 24 hours.

Finally, the above calculations were made on the basis of a Telpak A service operating either digital at about 40 kb/sec, or analog, using 40-kc bandwidth. If Telpak A were obtained as twelve 4-kc (nominal) channels, the same capacity could be maintained if each 4-kc channel carried data at 3300 bits per second. This is altogether feasible in a high quality dedicated network. However, if we were to settle for a 2400 bps transmission per 4-kc channel, we would require 40% more channel capacity to handle the total load in the same 24 hour period.

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The supporting calculations for Table 6-2 follow:

Calculation A

How many bits/page of typed copy?

Assumptions:

64 characters/line
7 bits/character (ASCII code)
40 lines/page

Hence,

bits/page = 64 x 7 x 40 = 18 kilobits

or assuming Telpak A @ 40 kb/sec rate, it would take about one-half sec/page of typed copy.

Calculation B

For a high resolution photo:

a. In digital transmission, how many bits are there per photo?
b. In analog transmission, what time-bandwidth product is required to transmit a photo?

Assumptions:

1000 line/inch resolution
Photo size 8 x 10 inches
Tonal gradations—16 (4 bits, pulse code modulation)

1. For digital transmission:

bits/page = 80 sq. in. x 1000 elements/inch across x 1000 elements/inch down x 4 bits/element

= 32 x 10 bits/page.

Assuming Telpak A @ 40 kb/sec, it would take about 2.2 hours to transmit a page.

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2. For analog transmission:

picture elements/page = 80 x 1000 x 1000

= 8 x 10 elements

or picture time x bandwidth/page

$$= 40 \ \frac{\text{megacycles}}{\text{sec}} \ \text{x} \ 1 \ \text{sec}$$

Given a Telpak A 48 kc group channel, and using AM-VSB modulation which accepts a 30 kc baseband, it will take 1330 seconds or about 1/3 hour to transmit. FM modulation would take about 50% longer. Note that while analog transmission requires a fraction of the time required for digital transmission, its signal-to-noise requirements are much higher for equal quality.

Calculation C

For a low resolution facsimile

Assumptions:

For 100 lines/inch resolution
Photo size—8 x 10 inches
Tonal gradations—16 (or 4 bits, pulse code modulation)

Here transmission time is 1/100th of that for calculation B, i.e.,

1.3 minutes for digital transmission
12 seconds for analog transmission

Calculation D

For a low resolution, black-white facsimile

Assumptions:

100 lines/inch resolution
Photo size—8 x 10 inches

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Here, digital transmission time is 1/4 that of calculation C, while analog transmission time is unchanged. That is, approximately

18 seconds for digital transmission and
12 seconds for analog transmission.

The merits of analog versus digital transmission were analyzed.

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These comments are addressed to the question of transmission of analog (voice, facsimile, video) and digital (binary) information over long-haul trunk facilities.

Without special processing, analog information is usually sent as analog, and digital information as binary modulates in phase or frequency of a suitable carrier (by a data modem).

However, analog information can be translated into a digital signal by A/D conversion, most usually accomplished by PCM (pulse code modulation). For example, a 4-kc voice signal can be digitized by sampling the signal at a rate twice that of the highest frequency and then assigning the sample into one of 64 amplitude level slots. Six bits uniquely specifies 64 levels. Hence, a 4-kc voice signal for one second can be represented by 4000 x 2 x 6 = 48 kilobits.

48 kilobits per second can be accommodated by a good 48-kc channel. Hence, digitizing a voice signal has expanded the bandwidth from 4 kc to 48 kc. However, it has reduced the signal-to-noise requirements very significantly, since the digital receiver must distinguish between only two signal conditions.

On the other hand, the transmission facilities currently available to an EDUCOM network do provide a good signal-to-noise ratio, while their cost is directly related to the bandwidth required. Hence there is a market cost advantage is *not* digitizing signals normally analog for transmission.

Normally digital (binary) signals require low signal-to-noise ratios, of the order of 15-20 db, for errors to be sufficiently infrequent for most applications. However, trunk facilities provide much better signal-to-noise ratios almost all the time. Efficient transmission of data is realized by multilevel modulation which requires each signalling element to carry more than one

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bit of information (e.g., eight level would carry 3 bits per element) and by more complex modulation means, such as vestigial sideband AM. Such a signal begins to "look" analog—which is the direction to go for minimum bandwidth occupancy, but at a signal-to-noise ratio cost.

One advantage of digital transmission worth noting is the ability to wipe off noise and distortion by regenerating the signal along the transmission path. In this way, irretrievable mutilations of the signal can be prevented. Such regeneration is not possible with analog signals.

Another advantage of digital transmission is the ability to encipher the signal to prevent unauthorized access to the information.

In summary, existing common carrier systems which are operational, such as radio relay (TD-2, TH, TJ) and coaxial cable (13) were designed for analog transmission and are most efficiently used for transmission in analog form of voice and TV. The same will be true for the first versions of satellite communication systems.

However, in development by the Bell Telephone Laboratories, is a nonradiating, wideband system based on a .0270 in coaxial cable using regenerative repeaters every mile. This system is specifically designed for time-division multiplexed (TDM) capable of transmitting 224 megabits per second at a low error rate. The availability of such a system requires a new look at the approach EDUCOM should follow.

The next item suggests that the system design should insist on advanced performance.

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EDUCOM can either install and operate its own transmission facilities or rent channels and services from carriers such as American Telephone and Telegraph, General Telephone and Electronics, or Western Union. In either case, EDUCOM can settle for conventional performance, or it can insist on advanced performance and features which should result in lower costs and improved performance.

A list of some of the features and practices that this writer believes desirable and achievable is provided for general guidance.

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EDUCOM owned transmission facility

1. All solid state design for improved reliability, lower maintenance, unattended operation, improved performance, and reduced primary power. One watt of solid state power is currently possible at 4-6 ghz.
2. Propane powered fuel cells as a primary power source for many months of reliable, unattended service.
3. Diversity combiners with smooth transitions to avoid error-creation in high speed data.
4. Special attention to the use of linear modulators and demodulators now available to reduce distortion under peak conditions.
5. Special attention to a reduced delay distortion FDM channel. Data rate and error rate over a 4-kc channel is directly related to the delay distortion incurred by the channel filters. Improved and equalized filters can provide 4800 bits per second transmission in a nominal 4-kc channel.
6. Improved data modems (possibly multi-level AM-VSB) to maximize the bit rate and minimize the error rate.
7. Use of tunnel diode low-noise preamplifiers and possibly FM feedback demodulators.
8. Improved circuit switches to reduce impulse noise creation.
9. Consideration of the use of a diversity channel to carry store and forward data during periods of minimum fading.
10. Consider better system utilization via store and forward techniques (both analog and digital).

Common carrier leased services

1. Improve 4-kc channel delay distortion characteristic to maximize bit rate and reduce error rate.
2. Obtain data on noise, distortion, and diversity interruptions for review with an eye on obtaining assurances of better channels.
3. Improve system performance on Telpak services by requesting elimination of all old group dropping filters and their replacement by newly designed filters having markedly reduced delay distortion.

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4. Make maximum usage of wider bandwidth, Telpak D, C, B, A (in that order) to take advantage of reduced cost/cycle of bandwidth.

5. Request performance data and availability of 4800 bps data modems for 4-kc channels and 76.0 kbps modems for 44-kc channels. This will reduce transmission costs.

This list is by no means complete. Some of the enumerated items will probably be accepted at once since they are already incorporated in some newer, available equipment and practices. Other items will raise a storm of protest and possibly more. All to the good! Let's see if they are meritorious, realizable, and economically and operationally desirable.

For long-distance, wide-band transmission, three basic options for transmission media were compared.

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This section will briefly tabulate some of the more important features of microwave radio relay, coaxial cable, and satellite communications, relevant to the consideration of EDUCOM transmission system alternatives.

While microwave radio relay and coaxial cable are capable of transcontinental connections, as well as connections as short as a mile or less, the economics of satellite communications dictates long spans. Hence, such systems would have to include both radio relay and cable connections for local and regional distribution and satellite links to span half-continental and continental distances. See Table 6-3.

(Table 6-3 does not include the 224 Mb/S Digital Repeatered Coaxial Cable System which will probably become operational in the not too distant future. Details of this system can be found in the Bell System Technical Journal, of Sept. 1966).

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Table 6-3. Comparative Features of Communications Methods

	Radio Relay	Coaxial Cable	Satellite
Baseband Capacity	8 mc 0.3 - 8.3 mc	3 Coaxial system provides either 1860 telephone channels or 600 telephone channels plus a 4.2 mc TV channel 0.3 - 8.3 mc	8 mc
Performance	Very good, but some outages due to propagation difficulties; see below		Excellent
Propagation problems	1. Occasional "inverse bending" fades due to temperature inversions. This causes an outage. 2. More frequent deep fades due to multipath; largely mitigated by diversity. 3. Not enough is known about error rates due to fading and due to diversity action for high speed data.		1. Very few problems, occasional drop in performance due to snow on radome. 1 error for 10^9 bits was measured.

Table 6-3—Continued

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	Radio Relay	Coaxial Cable	Satellite
Equipment	Good now—with a hot standby, excellent. Solid state design will provide excellent reliability.	Very Good	Excellent
Frequency bands	4 gc 6 gc 11 gc (for short hops) due to weather limitations.	L3: 0.3 to 8.3 mc ETV: 8 - 88 mc	4 gc down 6 gc up
Operational status (Continental U. S.)	Operational	Operational	Operational in 1967 - 1968?

Background information on experience with television and voice conferences was presented.

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Work has been done at the Bell Telephone Laboratories and elsewhere toward devising communications systems which will effectively link a group of people assembled in one conference room with another group in another conference room. The two rooms may, of course, be in different cities. Two-way television, remote blackboards, and voice communication have been provided in various combinations. These systems have been tested enough to prove that successful conferences can be held with their use.

The use of television. Three conference systems which have been installed in the New York area make use of two-way television. One of these, designed by the Bankers Trust Company to link two of its branches, has

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been very heavily and successfully used for several years. As many as five conferees seat themselves around one side of a small round table, all facing a twenty-seven inch television screen mounted in one side of the room. The picture which they see is somewhat higher quality than broadcast television (625 line—8 megacycle) and provides an excellent view of the five conferees in the distant conference room. Wide angle lenses have occasionally been used to accommodate more than five people in the picture, but the feeling is that the resulting images are too small to be useful and that five is about the maximum number of people that can be shown on such a system. A camera mounted in the ceiling looks down at the center of the table and can be used to transmit printed or handwritten documents. Approximately two-thirds of an 8-1/2 x 11 inch typewritten sheet can be transmitted with excellent legibility.

This system is used almost every hour of the day. The bank makes a very careful continuing analysis of the cost of the system and the returns which result from saved travel time. Their conclusion is that the system is worthwhile in spite of the fact that the A-Z-A video circuits (approximately 4 miles) cost about one thousand dollars per month. Several times they have considered giving up the video and retaining only the audio but have always concluded that the picture is worth what it costs.

In another bank installation in New York an attempt is made to use a television camera which looks down the length of a long conference table. In this case the picture is very much less satisfactory and adds little to the communication.

The New York Telephone Company has recently installed a video conference system between New York City and Albany. This system uses standard broadcast quality. It accommodates approximately five people at each end as does the Bankers Trust System and seems to work satisfactorily.

Voice transmission. The transmission of voice between groups of people is not as simple as it might at first appear. A severe problem arises from the fact that, when the volume is high enough to provide a comfortable listening level, the system tends to sing. Several remedies for this difficulty have been used in various combinations, and others are currently under study.

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The current status is that quite useable results can be obtained but there is room for improvement. It is believed that work now in progress may accomplish this improvement.

Two other variables relating to voice transmission have been studied. One is the use of stereo and the other is the use of broader bandwidth than is provided by a telephone channel. The use of stereo makes it possible to locate the received sound spacially and thereby to determine approximately where the talker is seated. This makes it possible to concentrate on one of the two or more talkers who may be speaking at the same time. In such a case, intelligibility is noticeably improved. Another effect of stereo is to reduce the objectional effects of reverberation. There is less of the "rain barrel" sound which one gets when the talker is not near the microphone. The great disadvantage of stereo is that it costs twice as much to transmit as monaural. Studies to date suggest that although the advantages of stereo are noticeable, they are probably not worth the cost.

Bandwidths of 5 kc and 8 kc have been used to produce "high fidelity" conference systems. These broader bandwidths provide noticeably more natural reproduction than is provided by the much more readily available 3-kc telephone bandwidth. There is also a slight improvement in intelligibility; but the cost, particularly for a long circuit, is high. It is believed that ordinary telephone circuits provide adequate quality for most applications.

For purposes relating to documentary information systems Table 6-4 shows the various document control functions with their associated options:

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Technologies involved here involve largely electronics, optics, and imaging. None of the demands of an EDUCOM network are beyond the capability of our technology, although some of them will require new combinations of existing technologies. In particular, the required communications technology exists with respect both to capability and to potential economics. If rate schedules were adjusted to reflect cost properly, the economics for an EDUCOM network would probably be satisfactory. Optical and imaging technologies exist for meeting all the requirements considered here, particularly in areas of new imaging technology which have not

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Table 6-4. Document Control Functions

Generation	Indexing & Abstracting	Transmission	Transformation	Storage	Retrieval	Reproduction	Dissemination
1. Control a. Computer b. Human c. Semi-automatic d. Automated 2. Transducer a. Pen b. Typewriter c. Printer d. Camera e. Recording instrument f. Recording display	1. Machine index a. Manual b. Semi-automatic c. Possibly automatic 2. Human abstract a. Manual b. Semi-automatic c. Automatic	1. Physical transport 2. Optical 3. Electronic a. Facsimile point-scan bandwidth compression b. Keypunched digital c. Possibly character recognition digital	1. Optical a. 1-1 b. Semi-micro c. Micro: microfilm microfiche aperture card 2. Electronic a. 1-1 b. Semi-micro c. Micro d. Digital storage	1. Full size 2. Semi-micro 3. Micro: microfiche microfilm aperture card 4. Magnetic tape	1. Retrieval control a. Computer b. Human 2. Retrieval mechanism a. Automatic b. Semi-automatic c. Manual	1. Location a. Centralized b. Localized c. Nodal 2. Method a. Physical imaging: microform semimicro full size b. Electronic: simplex broadcast selective party-line	1. Local network intra-university 2. Global network inter-university 3. Functional network by discipline

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yet been applied to the market. Based on such technologies, electronic document transmission and low-cost document reproduction on demand, particularly in the education field, will soon become commonplace, as will the use of both micro and semimicro forms for document reproduction. It would appear that such developments should be taken into account in designing an EDUCOM network.

For those who assume automatically that the problems of document handling are difficult but those of digital data handling are trivial, the following presentation deals with some of the problems involved in handling bibliographical data.

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I. The Data

Of course, the problems are infinite in number. Staff and equipment considerations would require the enumeration of a whole series of complex inter-related dilemmas. Consequently they are not covered here. These notes will only cover certain general problems in the acquisition, processing, and output of bibliographical data for automated systems.

Let's start with the bibliographical reference itself, the basic form of which will be called the *BIBLIOGRAM*. Traditionally this is the information specifically generated from a particular publication by a library descriptive cataloging operation. This information is supposedly a copy of the title page of the publication and *uniquely identifies* it as that publication. The bibliogram commonly includes: author name(s), title(s), publisher(s), date(s), and descriptive physical information such as paging, illustrations, etc.

Despite many attempts at standardization, various rules, the tremendous influence of the Library of Congress, and stereotyped library school training, there is actually a great deal of variation in the content and form of bibliograms. They are often abridged or abbreviated when used as references in an article. They may be expanded in a library card catalog (for example, the author's birth and death dates are commonly added). Errors in the bibliogram are not rare. Almost every agency using or citing publications develops certain small peculiarities in its bibliograms (and indeed the actual

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consistency within variations and inconsistencies between systems obviously create problems in sorting, searching, and output from machinery). Almost immediately the reaction of data-processing people is the demand for universal standards and rigid requirements for inputs of such information. This is not necessarily a satisfactory answer to the problem and alternatives will be noted later.

Superimposed or added to the bibliogram is a variety of other information used in retrieving or in manipulating the bibliographical data system. Three categories should be noted: (1) predicative information, (2) operational information, and (3) textual information.

Predicative Information is that which is attributed to the publication and is traditionally generated by library subject cataloging operations. This includes: classification codes, subject headings, descriptions, special location numbers, etc. Obviously there is even more variation in such assigned information than there is in the identifying bibliogram itself. Classification codes may be: Dewey decimal numbers, Library of Congress alpha-numeric codes, universal decimal classification numbers and special characters, or an infinite array of special categorizations by any particular institution. Here again, the practice is inconsistent even when the system is theoretically the same. Again the data processing requirements seem to dictate some standardization, and again the needs of at least some of the users preclude it.

Operational information is that with which a particular agency does the accounting, inventory, and related housekeeping tasks required within its own internal operations. This includes pricing, number of copies, vendors, bindery data, dates received, accession numbers, purchase order numbers, invoice dates, transaction numbers, dates charged out, due dates, etc. Some of this information may be useful to other agencies and some of it is not. Of course it is quite individualistic but it might need to be accommodated as a useful byproduct of any automated system—in spite of the complex problems which it presents.

Textual information is that which is derived or excerpted from the actual content of a publication itself. This includes abstracts, reviews, or even the complete publication in some systems. This material has not

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traditionally been handled by the library system, but a need for it is foreseen (increasingly humanities researchers, linguistic analysts, concordance and glossary compilers, as well as translators, are demanding such material). The problems here involve adequate representation of the text with the limited typographical capabilities of mechanized systems. For example, what is to be done about: chemical formulae and notations, mathematical or electrical symbols, special punctuation marks, foreign alphabets, type font peculiarities, artwork, manuscript textual qualities, etc.?

II. Organization and Handling Aspects

In general, it is wise to note that there is ordinarily a requirement for establishing the data base (a master file of information) in the computer, and there is also the need for revising or adding to that file. Finally there are a number of possibilities involving the use of such a file.

A. Organizing the system

If care if not taken, serious problems can be created by exceeding the capacity of equipment or of requiring reaction times which cannot be delivered by it. These problems will not be considered further in these notes since they are deemed obvious. It may not be so obvious that adequate revision, deletion, or addition procedures must normally be provided for any actively used file. Failure to provide for such procedures will also create serious problems. Consequently, the master file of information must be blocked, batched, and possibly split up in the system so that the expected revision may be accomplished as needed. For some applications, the master file of information may be blocked onto one tape and revisions may be accumulated on a second tape until sufficient volume is obtained—at which time a new tape can be produced to incorporate the changes. Such a system means that most operations may require the search and checking of both tapes sequentially and this may or may not be a problem.

Very large files may require that the data be split in various ways. Sometimes this is a simple chronological arrangement of oldest to newest (and presumably

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most useful). A particular portion of the data may be required most often and might better be disassembled or abstracted from the master file for easy access. Such problems almost always must be considered within the specific context of a problem to be solved. Generally, insufficient study has been given to these file organization problems for library applications. This will have to be corrected in the near future.

A generalized organization of the handling processes is shown in Figure 6-1 to serve as an outline for further discussion of bibliographical data problems.

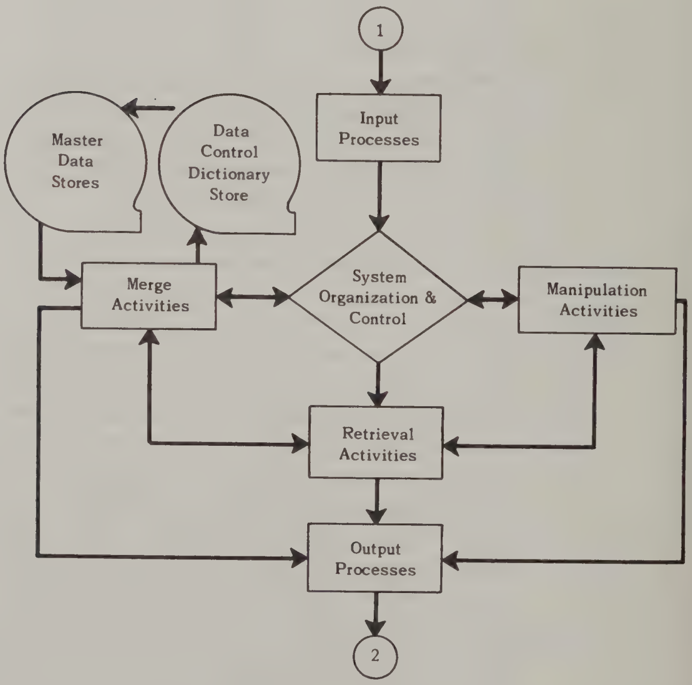

Figure 6-1. Representative Handling Processes for a Bibliographical System

B. Input

As noted before, there is considerable pressure for accepting only a very rigid and standardized information format as input data. A solution for large and

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complex systems will almost assuredly delay, if not doom, a project at this time. Most bibliographical agencies simply cannot invest manpower in re-working their data for interagency systems. This means that a system that can accept unedited, multi-media input can almost assuredly give some output sooner than a very restrictive and selective system. In the case of the EDUCOM prototype this may well imply that input editing and rework will have to be provided to gain satisfactory input data.

Of course the media for input data will also be a factor, but again it should be restrictive—if at all possible. The ability to accept tab cards, paper tape, mag tape, and communication signals of various types would be a decided asset. This may mean that considerable transformation of input data from one media to another would be required.

The same comments apply to the wide variety of machineable codes which exist. Perhaps the American Standard Code for Information Interchange (ASCII) will be of some assistance in solving this problem eventually but it is still under revision and industry adoption may be slow in coming.

C. Internal system control

The characteristics of the computer equipment will probably create many problems in compatibility of the inter-agency data systems. Here again, this is a technical matter beyond the scope of these notes. Suffice it to say that the storage capacities, types of storage, word lengths, available software packages, and interface requirements will need to be considered for every application.

D. Merge

This activity is one of the most important considerations in handling a variety of data files, and yet has probably received the least attention of all. This is the type of operation by which data additions or revisions can be placed in the master file, but it is also the type of operation by which duplications or gaps must be detected. It is here that all of the inconsistencies, variations, or

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errors can cumulate and produce serious problems. For example, successful searching terms must match those actually used by any specified system. Author names must match the form used in the particular file for that type of search. Journal entries must be matched to enable adequate Union Listing of publications. If duplications of references are not detected, very unhappy users of the system will be sure to protest the inadequacy of the files.

To solve such problems (and also to allow for some freedom at the input stage), the suggestion is made that a number of control dictionaries might be designed for this part of a system. These dictionaries may be very similar to the authority files used in traditional library systems. They would consist of the approved entry form for any desired element of the bibliogram (such as journal title) associated with all of the respective variants of that entry. The variants therefore lead to the common approved form of the element (or its code number).

In any case, this aspect of handling bibliographical data is deemed very important.

E. Manipulation

This activity involves the "massaging" of the data in various ways. Problems in sorting, sequencing, or alphabetizing presumably might be resolved here. Note should be made also that the re-arrangement of selected bibliograms to meet differing output requirements may be a desirable feature of a system. Abridgement of a citation might be desirable, for example. Hopefully there are already many available programs which could be adapted to resolve any problems inherent in this activity.

F. Retrieval

The many, many reports and articles being written about "information retrieval" probably mean that the problems in this area have been the most widely studied of any noted thus far. Commonly, these studies have approached the problems from the searcher's point of view in large part; but increasing attention is being

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given to the inconsistent methodology by which retrieval mechanisms are imbedded in the bibliographical data file. The variations in the systems for assigning such predicative information have already been noted. Perhaps it is only necessary to state that these variations are an inherent characteristic of information itself (which is constantly being relabeled and recombined for the infinite uses derived from it). The solution to these problems does not appear to lie in more rigid and more highly controlled systems. The solution appears to be proper allowance for this aspect of information retrieval, and we must provide for a great deal more feedback from each user's interaction with the information. Again the control dictionary for searching terms and strategy seems to be an exploitable characteristic of mechanized systems.

G. Output

The payoff is the output. A major problem here is to offer the user of the system enough options (at the beginning of his search) so that he may receive it in the form most useable—without unduly interfering with his actual manipulation and use of the information in the system. Certain aspects of this problem are again produced by the technical characteristics of the equipment itself (such as limited type fonts, output speeds, display characteristics, etc.) and are not covered in this paper.

Interagency network systems will certainly compound these problems many times. On the other hand, they also offer increasing hope for more satisfactory output. (Interestingly enough, little attention has been given to the form and content of the output products from the proposed EDUCOM prototype—even though it may be the most significant factor in terms of user satisfaction and system success).

III. Conclusion

Perhaps the major factors related to the mechanized handling of data should be noted: the size of the data file (number of bibliograms, number of characters, variations in size of bibliogram elements); desired entry points required; revision and addition volume and requirements;

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access requirements (volume, rates—i.e., on-line, batch processing); statistical and administrative control features required; output form and content required; output volume and rates required; available equipment capabilities and constraints; relationships internally within the system and externally with other systems; priority and budget considerations; training of staff and related personnel aspects. Obviously, most of these factors pose a multitude of problems which have not been covered in these notes. Instead, a rather explicit outline has been given of the particular problems which are likely to be encountered in the generalized handling of bibliographical files. Similar problems are likely to be encountered in handling other types of data.

V. PROPOSED DESIGN APPROACHES

Early in the Summer Study, a preliminary network design was prepared in response to the needs of application groups to acquire a feeling for what the network capabilities might be. Later, a second group was assigned the mission of producing some competing notion to avoid congealing the design concepts prematurely. There was considerable doubt then that the ideas were different or that they were well enough specified for the comparison to be meaningful. Furthermore, there was some doubt in the second network design group as to their ability to produce anything meaningful without firm specification to traffic loads, geographical locations of nodes, etc.

The diagram, Figure 6-2, produced by the first network design group shows a nucleus network connecting to a line-switched network proposed to absorb unscheduled and large volumes of data interchange and to a video network proposed to carry video and TV services on an "as-needed" basis. Figure 6-3 is a glossary of symbols used in the preceding figure.

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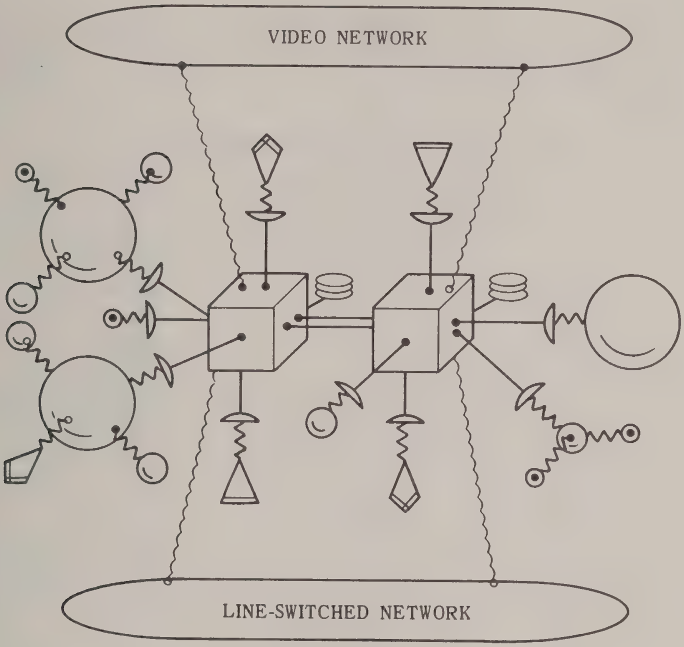

Figure 6-2. "A" Network Configuration

The second network design group produced the configuration shown in Figure 6-4 with the glossary of symbols given in Figure 6-5 and the accompanying comments:

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Principal features of design alternative "B":

1. The directory function is decentralized. Institutions with a responsibility for information would also be responsible for directory functions concerning that file.

2. While the round-robin transmission is shown in the chart as a wide-band system, it can be evolutionary. That is, it can begin with transmissions as simple as TWX or TELEX and expanded to include television and core-to-core computer communications.

3. The common routine for all services makes possible the lowest bulk rates for TELPAK services and reduces installation and maintenance costs for owned microwave systems. (NOTE: Adjustments in existing AT&T tariffs may be necessary for some kinds of service via TELPAK, etc.).

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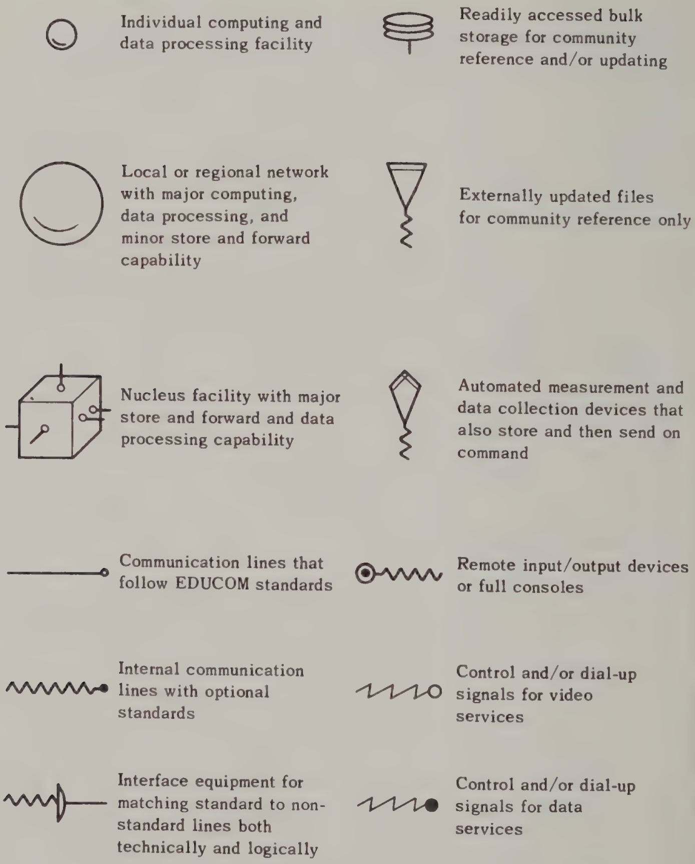
Individual computing and data processing facility
Readily accessed bulk storage for community reference and/or updating
Local or regional network with major computing, data processing, and minor store and forward capability
Externally updated files for community reference only
Nucleus facility with major store and forward and data processing capability
Automated measurement and data collection devices that also store and then send on command
Communication lines that follow EDUCOM standards
Remote input/output devices or full consoles
Internal communication lines with optional standards
Control and/or dial-up signals for video services
Interface equipment for matching standard to non-standard lines both technically and logically
Control and/or dial-up signals for data services

Figure 6-3. Glossary of Network Symbols—"A"

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4. The system, as presented, makes possible quite simple telephone and other communication services between institutions, without reference to centralized computer and switching facilities.

5. For most geographical configurations, the round-robin design reduces inter-city mileage and attendant transmission costs.

6. The full-duplex, closed loop configuration provides for automatic alternative routing in case of failure in any one loop segment.

7. Certain authorized users are not precluded from access to the system via the common-user dial telephone system.

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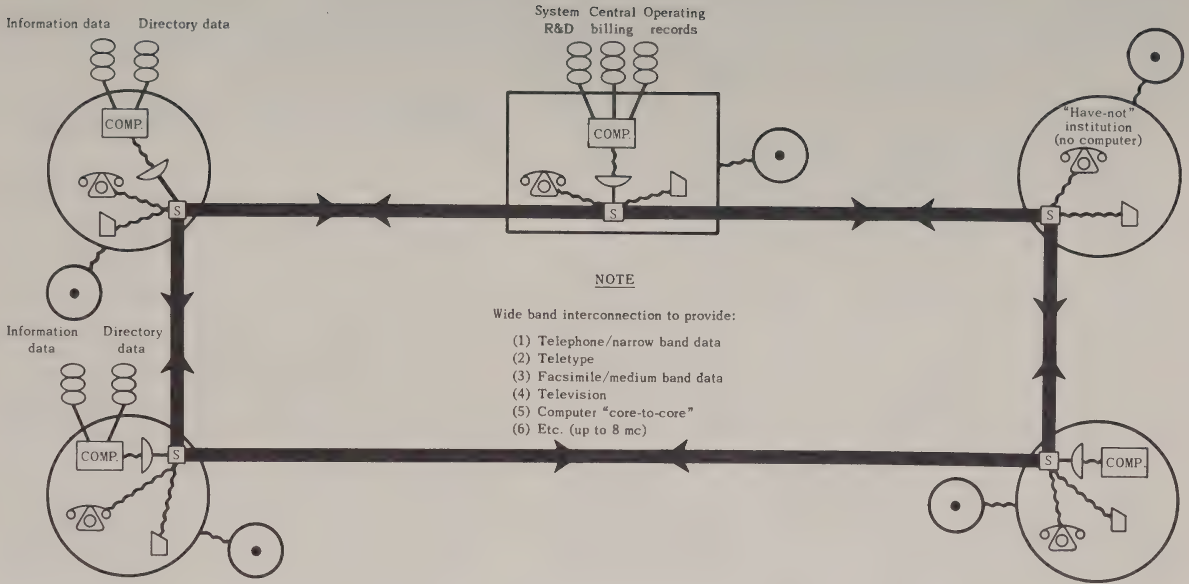

NOTE

Wide band interconnection to provide:

(1) Telephone/narrow band data
(2) Teletype
(3) Facsimile/medium band data
(4) Television
(5) Computer "core-to-core"
(6) Etc. (up to 8 mc)

Figure 6-4. "B" Network Configuration

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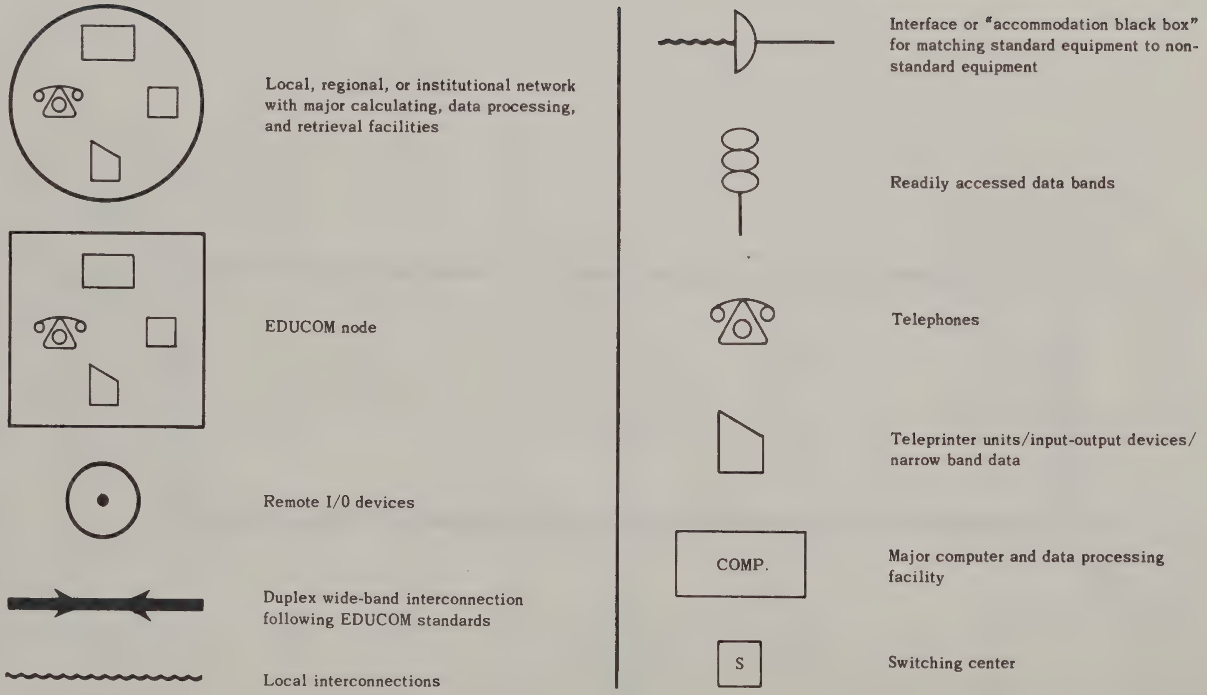
Local, regional, or institutional network with major calculating, data processing, and retrieval facilities
EDUCOM node
Remote I/0 devices
Duplex wide-band interconnection following EDUCOM standards
Local interconnections
Interface or "accommodation black box" for matching standard equipment to non-standard equipment
Readily accessed data bands
Telephones
Teleprinter units/input-output devices/narrow band data
COMP.
Major computer and data processing facility
S
Switching center

Figure 6-5. Glossary of Network Symbols—"B"

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It should be borne constantly in mind that no configuration of transmission paths or determination of technical capacity can be proposed seriously until it is known where the initial network nodes will be and what the initial mission of the network will be. A great many alternatives are possible in communications design, and abstract exercises are of limited utility, given the likelihood that the final communications design will be made by competent professionals.

Our purpose here is to suggest that certain principles should be observed:

1. The advantages of decentralization should be examined;
2. The network should be designed to accommodate, in an integrated package, a wide variety of communication services;
3. The final route should be designed to take into account communications economy, system reliability, and system flexibility for growth, operating refinements, and changes in the state of the art.

Two different comparisons of configurations "A" and "B" were made.

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The similarities and differences of the two designs listed below show that the important characteristics of the EDUCOM network lie in the communication links. The system components are identical in the two systems but the communications networks differ. Design A is centralized while design B is a decentralized loop system. Both networks A and B could provide identical services to users. Indeed the eventual EDUCOM Educational Communication Network will probably be a combination of loop and star arrays.

It should be noted that the proposed networks describe the hardware part of the EDUCOM system. Since the EDUCOM system is revolutionary in nature, on the basis of past experience we can expect the software part of system to be more difficult and expensive to design and construct than the hardware part of the system.

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Comparison of EDUCOM Network Designs "A" and "B"

Similarities in "A" and "B"

Network components

- Input consoles and other input-output devices
- Small computer facilities
- Regional networks
- Storage capabilities

Communication channels

- Standard wideband interconnections, full-duplex, expandable to meet communication needs
- Message switching—any facility may be connected with any other facility for information transfer
- Telephone and video networks provided

Differences Between A and B

	"A"	"B"
Communication Network Array	Star centralized, dual nucleus nodes	Loop decentralized, many regional nodes of importance, one EDUCOM node.
Communications Network	Information channels, auxiliary telephone and video channels (could be integrated)	Integrated package: information, telephone and video channels.
Message Switching Capability (Store and forward)	Major at nucleus nodes, minor at regional nodes	Major at all regional nodes in loop.

		"A"	"B"
XXIV Grabbe 7/22 Cont.	Communication Channel Capacity, "Pipe Size"	Large pipe between nucleus nodes. Smaller pipes for regional and local nodes	Large pipe for loop, smaller pipes for local nodes.
	Communication Routing	Single route	Loop provides alternate routes.
	Communication Cost	According to usage, bulk rates for some high traffic links	According to usage, bulk rates for loop traffic.
	System control	At nucleus node	Distributed
	System operations data collection	Centralized at nucleus node	At loop nodes, forwarded periodically to EDUCOM node.
	Data files	Built at regional nodes, complete files stored at nucleus nodes	Distributed at regional nodes.
	Directory	At nucleus node	Decentralized

In the second comparison reference is made to some alternative configurations considered by Group XV but not reproduced here.

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The salient differences of network configurations "A" and "B" delineated by Groups XIV and XV are as follows:

1. Capacity. Network A is primarily a store and forward data communications system of moderate capacity. Subsidiary and back-up services are provided, when needed and requested, by the existing lines supplied by a common carrier (switched 4-kc channels and video channels).

   Network B is conceived as a broadband channel handling all services, including video, telephone, teletype, data, etc.

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2. Directory and Control Functions. Network A is centralized in this respect, utilizing a centrally-located, computer-controlled complex to carry out the functions of system control, directory, operational records, etc.

   Network B is decentralized with respect to these functions.

Of small difference, yet deserving discussion because of seemingly undue importance paid to this feature, is the network connectivity; i.e., Axle and Spoke (Network A) vs. Round Robin (Network B). While Network B purports to be round robin in configuration, two of the four possible connectivities as set forth in Group XV's working paper of 22 July are in fact not round robin. As both Alexander and Kessler have indicated, the connectivity will ultimately be dictated by system reasons (i.e., geography, economics, utilization of existing facilities, and community of interest); and preference cannot be made now in the absence of the detailed system requirements.

3. Effects of Network A vs. B on the evolving EDUCOM network

   With Network A:

   a. Its capacity, being limited as noted above, will probably dictate, for overriding reasons of costs, that the trunk (kernel) transmission facilities be provided by an existing common carrier (ATT, WU) for the experimental prototype and operational stages of the system development. Once the decision is made initially to use common carrier, custom, orthodoxy, and continued utilization of already-made capital facilities will tend to insist on such continued use into the operational phase. For long-range reasons this may or may not be desirable.
   b. A centralized directory and control facility may be more expensive, unwieldy, and operationally undesirable than decentralized facilities. Whether it is more expensive or not depends on factors that cannot be quantitatively dealt with at this moment in the absence of system requirements.

      An example of a problem incurred by a central control facility may prove illuminating. Let us say a New Jersey or Massachusetts institution wishes to be connected into a New York facility. To make this connection via Michigan,

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for example, appears unwise for many reasons: cost of transmission based on dollars/mile, deterioration of transmission performance based on db or signal to noise loss per relay hop, and the increasing unavailability of microwave frequency channels due to worsening congestion. On the other hand, what is the cost of duplicating directories and data banks, and constructing and manning regional as compared to centralized facilities? These should be determined before a decision can be made.

c. Network A may inhibit the use of video, facsimile, and other analog media by reason of the non-inclusion of suitable trunk transmission facilities in the backbone system. When the use of such facilities requires dealing with a common carrier on an as-needed basis, subtle forces may inhibit its more general use.

With Network B:

a. By reason of its capacity, it may justify ownership of the microwave relay facilities by EDUCOM as distinct from renting channels. It may be possible to procure and install a prototype section (150-300 miles) of such a system by 1968.

b. Decentralized control centers may have major benefits as noted above.

c. The full gamut of services including TV, core-to-core transmission, voice, facsimile, data, teletype, etc., can be multiplexed into one broadband channel and demonstrated in the prototype system.

d. Frequency allocations may be more readily available now than four years hence, if it is later decided that Network A should have its own microwave relay system.

With regard to other effects of Network A vs. Network B, on control, finance, and management, including questions of interfaces, and legal, financial, and operational problems (other than described above), no significant differences are seen.

VI. SAMPLE COMMUNICATIONS LAYOUTS AND COST ESTIMATES

In the final week a communications network design proposal was prepared, showing three phases of development of an EDUCOM interregional network, with extensive video capabilities in the third phase.

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Ideally, it would have been desirable to base the proposed interregional EDUCOM network on a selection of specific EDUCOM institutions and some reliable information regarding the volume and type of data to be interchanged between institutions.

Since such data were unavailable, the present proposal is based on the following assumptions:

1. The EDUCOM Interregional Network here proposed will consist of a TELPAK interconnection (of viable channel widths) between the regional centers, as shown in Figure 6-6, which will provide EDUCOM institutions within each region convenient access to the network.
2. Phase I will consist of a minimum of TELPAK B or its equivalent between regional centers which may be expected to accommodate the heavier communications load and TELPAK A along lower density routes.
3. Telephone and data interregional trunk circuits attach to terminals at centrex dial switching facilities located at the national and regional EDUCOM centers. The regional switchboards are connected, in turn, to the switchboards of the member institutions within a region.
4. During Phase I a minimum of four voice-grade TELPAK B circuits will be subdivided to provide sixteen teletype trunk circuits between regional centers which can be accessed by the member institutions.

Also a minimum of two voice-grade circuits will be subdivided to provide eight teletype trunk circuits between the regional centers where lighter traffic density can be expected.

5. The dial-switched telephone circuits may be utilized either as standard voice communication circuits or for analog or digital data transmission through the use of acoustical couplers, inductive couplers or the use of Dataphone (AT&T) or Datatel (GT&E) instruments.
6. Regional centers may not necessarily be located on the campus of an EDUCOM member institution.

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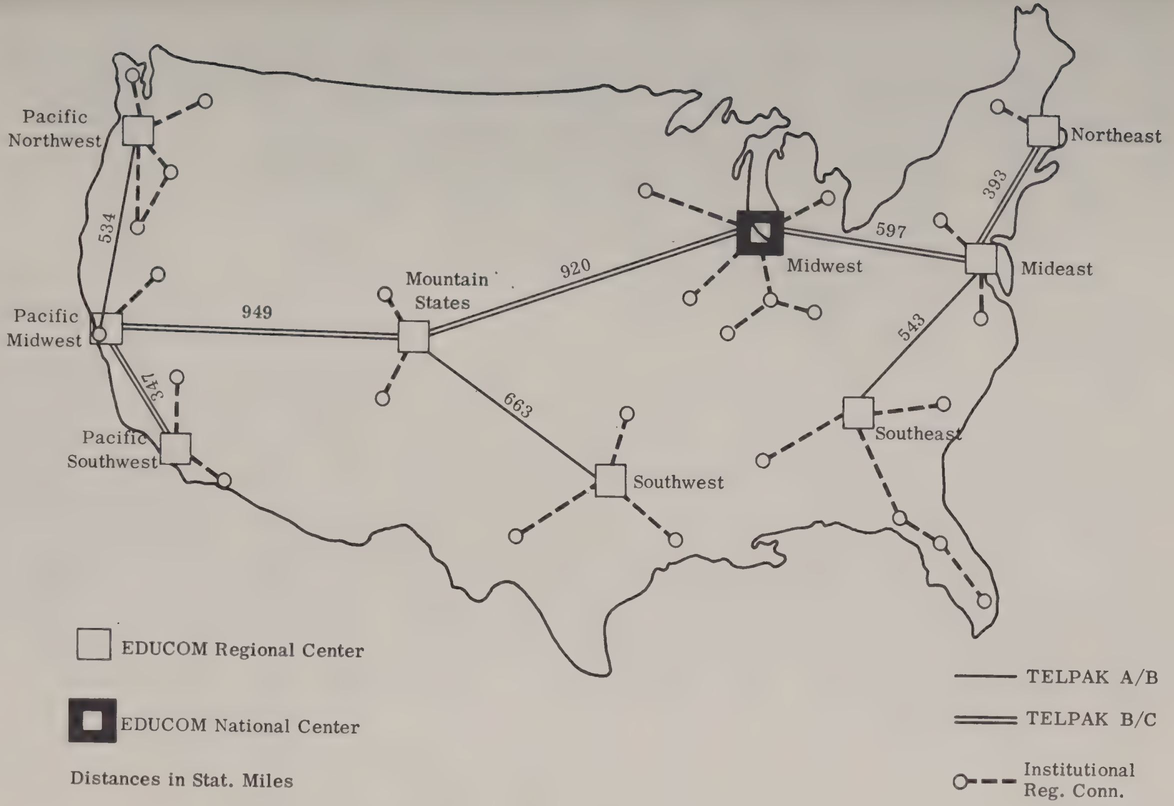

Figure 6-6. An Inter-regional EDUCOM Network

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However, it is recommended that the regional centers be located at or very near a major member institution, to minimize regional interconnection costs.

7. One of the regional centers (to be selected), such as the midwest region as shown on Figure 6-6, could be established as the national EDUCOM center where the master computerized directory and administrative functions could be located.

8. The regional EDUCOM centers are conceived to employ few, if any, personnel since the regional centers are regarded primarily as automatic switching centers to permit member institutions to gain convenient access to the main trunks of the EDUCOM network.

9. The responsibility for providing the regional interconnections and interfacings between the member institutions and the nearest EDUCOM regional center may be subject to negotiation. However, access to the national EDUCOM computer directory and other computer facilities located at other member institutions may be accomplished through the nearest regional center via local TWX/TELEX facilities so that the regional network costs would be more nearly proportional to the actual "on-line" time.

10. Facilities can be provided so that certain non-EDUCOM but otherwise authorized groups or individuals (a local doctor, for example) may gain access to the EDUCOM network (and hence to the poison-control data banks). It must be emphasized however that once access to the network is achieved, it should be impossible to gain access to the common-user telephone system at a distant city, otherwise EDUCOM may well find itself in a very vulnerable bargaining position.

Summary of Annual Leasing Costs

The following leased costs are based on current tariff filings which have been expressed in terms of annual rather than monthly costs and have been broken down into the three basic categories as follows:

1. TELPAK Interexchange mileage costs
2. Channel terminations
3. Channel switching

In addition, the development of the EDUCOM network has been assumed to progress in three phases, as follows:

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Phase I: TELPAK A for the single-line router in Figure 6-6.
TELPAK B for the double-line router in Figure 6-6.

Phase II: TELPAK B in place of TELPAK A in Phase I
TELPAK C in place of TELPAK B in Phase I

Phase III: Same as Phase II but with the addition of one full-duplex video (tv)/audio channel along single-line route in Figure 6-6 and two full-duplex video/audio channels along the double-line routing in Figure 6-6.

The annual leased costs are summarized below for the three phases:

Facility	Annual Cost		
	Phase I	Phase II	Phase III
TELPAK Interexchange	$1,082,640	$1,379,400	$ 1,379,400
Channel Terminations	146,640	320,880	320,880
Channel Switching	75,960	173,760	173,760
Video (TV)/audio (Color)	---	---	13,553,220
	$1,305,240	$1,874,040	$15,427,260

TELPAK channels, as listed in Tables 6-5, 6-6 and 6-7, allow large users of communication channels to obtain groups of channels at rates lower than combined individual channel rates. Various types of individual channels may be included in TELPAK ranging from very low speed signaling channels up to and including the use of an entire TELPAK channel for transmission of high speed data or combinations of such uses of channels. For example:

TELPAK A—12 voice grade channels
or 11 voice grade channels
and 12 75 baud channels
or 11 voice grade channels
and 4 150 baud channels
or various combinations of voice and data channels not to exceed the equivalent of 12 voice channels.

Note: 75 baud channels and 150 baud channels cannot be mixed in a given 1 voice channel.

Table 6-5. Summary of TELPAK Facilities

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Old Service Terminology	Equivalent Voice Channels	Approximate Allocated Carrier Spectrum	New Service Terminology
TELPAK A	12	48 KHZ	5500
TELPAK B	24	96 KHZ	5600
TELPAK C	60	240 KHZ	5700
TELPAK D	240	1 MHZ (approx.)	5800

ALTERNATE VOICE/DATA CHANNELS OR DATA ONLY CHANNELS

500 Series Channels

Old Service Channel Terminals	Equivalent Voice Channels	Approximate Bandwidth	New Service Channel Terminals
TELPAK A1	12	0-20,000 HZ.	5501
TELPAK A2	12	40.8 KB/S plus 1 voice freq. channel for coordination	5502
TELPAK A3	6	29-44 KHZ plus 1 voice freq. channel for coordination	5503
TELPAK A4	12	Max. 50 KB/S plus 1 voice freq. chan. or control chan. or on an alternate basis (Sync. or non-sync. data)	5504
TELPAK A5	6	19 x 2 KB/S plus 1 voice freq. channel	5505
TELPAK C1	60	0-100,000 HZ.	5701
TELPAK C2	60	105 KB/S plus control channel and 1 voice freq. channel	5702
TELPAK C3	---	Deleted	5703
TELPAK C4	60	U. S. Govt. only	5704
TELPAK D1	228	500 KB/S plus error checking and control chan.	5801

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Table 6-6. Cost Detail

	PHASE I	PHASE II	PHASE III
TELPAK (5000 SERIES CHANNELS)			
INTEREXCHANGE MILEAGE	$ 90,220	$114,950	$ 114,950
CHANNEL TERMINALS			
Telephone	3,900	9,300	9,300
150 Baud	3,120	7,440	7,440
NARROW BAND DATA			
150 Baud Station Arrangements	5,200	10,000	10,000
TELEPHONE			
Local Access Lines	500	1,000	1,000
Interexchange Access Lines	1,750	4,000	4,000
Interexchange Trunk Lines	3,600	9,000	9,000
Selective Routing Arrangements	480	480	480
SUB TOTALS	$108,770	$156,170	$ 156,170
VIDEO			
INTEREXCHANGE MILEAGE	---	---	1,025,368
AUDIO			
INTEREXCHANGE MILEAGE	---	---	104,067
TOTAL MONTHLY CHARGE	$108,770	$156,170	$1,285,605

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Table 6-7. Network Facilities Summary

Terminal Points	Size TELPAK		Number of Telephones		Number of 150 Baud		Number of 2-way Video–Audio
	Phase I	Phase II	Phase I	Phase II	Phase I	Phase II	Phase III
Portland - San Fran.	A	B	10	20	8	16	1
Dallas - Denver	A	B	10	20	8	16	1
Wash. - Atlanta	A	B	10	20	8	16	1
L. Ang. - San Fran.	B	C	20	50	16	40	2
San Fran. - Denver	B	C	20	50	16	40	2
Denver - Chicago	B	C	20	50	16	40	2
Chicago - Wash.	B	C	20	50	16	40	2
Wash. - Boston	B	C	20	50	16	40	2

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Telephone switching is accomplished through the use of telephone company central office equipment. This is the same equipment that is used to switch the regular long distance telephone network.

Operation is very similar to that of the long distance network in that the same telephone instruments are used and that a discrete seven digit number is assigned to each telephone on the private switched network.

This network allows any person on any EDUCOM campus to dial direct to any other telephone on any other EDUCOM campus and to EDUCOM regional or national centers.

Conclusions

In the short time available, it is not possible to determine accurately the cost of a complete private microwave system that could be operated by EDUCOM to provide the same type and quality of transcontinental communications services as those which could be supplied by common carriers.

Conceivably, by the time a need for a transcontinental multi-channel voice/data and color television network arises, the use of a satellite relay with three earth stations located in the east, the midwest, and the Pacific may become a practical economic reality. The final choice for the transcontinental network will then be made between the services provided by the common carrier, a private ground-based microwave link, a private satellite relay, or the CATV Networks which are certain to expand.

In any event, it must be recognized that a need will always exist (in the foreseeable future at least) for a regional ground-based network to provide flexible intraregional communications between EDUCOM institutions regardless of the way in which the regions are interlinked to provide a nation-wide network.

In fact, the most practical approach to a networking problem of this magnitude may be to implement the network initially on a regional basis and then base the expansion plans on the regional experience gained.

Another paper produced a complete costing of a national network laid out with a single national control center, as a guide to what system communications costs might be. The design called for two phases, the second of which would provide for video. It is not quite evident how to reconcile the substantial difference in costs for video between the two layouts.

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This working paper was prepared only to present some ideas of what form a network might take and some order of magnitude of costs based on leased services presently available from common carriers.

This network configuration in no way represents specific network design, as this can only be accomplished after thorough and careful consideration by experts in the several specialized fields involved in designing networks of this magnitude.

All node locations, types of service, quantity of service, and the basic network layout were supplied by the working group members.

A rough sketch of the United States with centers of population and centers for research and education was drawn, Figure 6-7. The centers or nodes were listed in two groups, Phase I and Phase II. Providing services to the remainder of the nation, with communication to each state or region could be considered Phase III.

Some comments on the services provided:

1. Private line telephone network

   These lines are switched in telephone company central office and provide direct dialing between all telephones connected to the EDUCOM network via various institution PBX's or telephone nodes.

2. Low speed data links: Teletype (150 baud channels)*

   These lines could be connected between the EDUCOM node and user nodes such as institution computers used as interface devices or could directly connect I/O devices to the EDUCOM network. All

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*The terms "150 baud channel" and "Teletype channel" are used to designate the same service.

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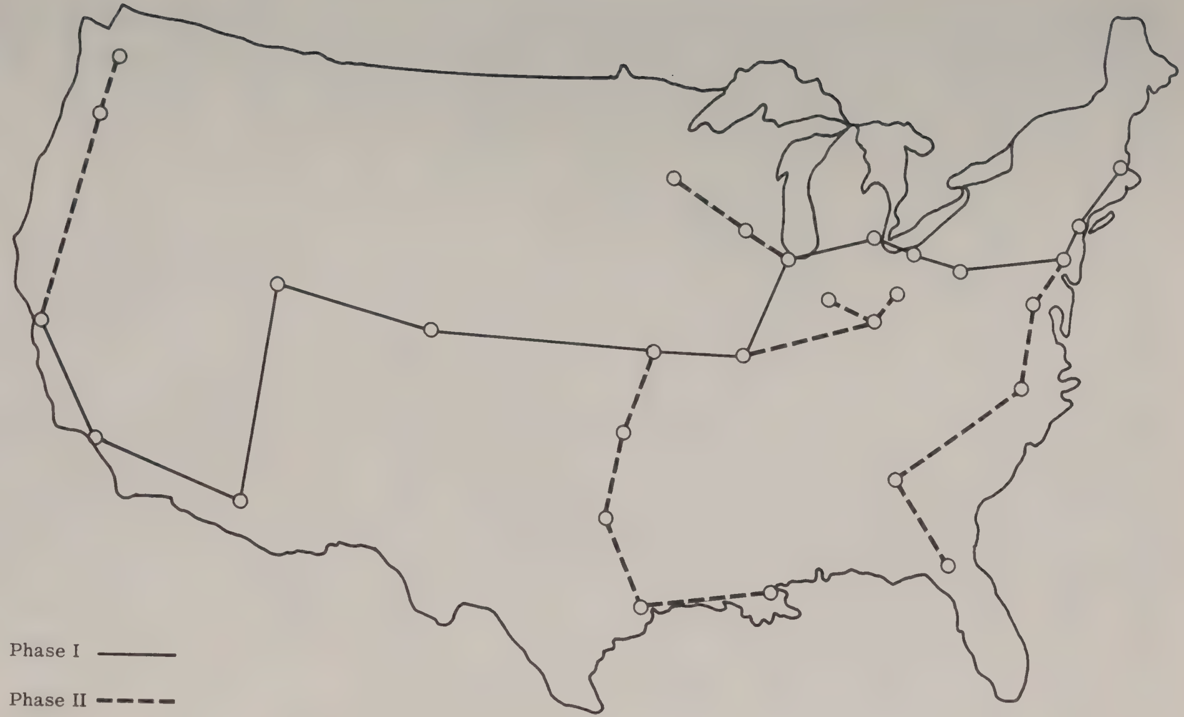

Figure 6-7. Preliminary Network Nodes

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inquiry-response traffic and relatively low volume data messages could be handled with the facilities.

3. TELPAK

Channels of both preceding grades are routed through various size TELPAK channels for rate purposes.

4. Television

All locations on the network are connected via color two-way video and associated audio channels (5 K.C.). On operation, any two nodes may transmit video and audio to any other two nodes simultaneously as long as each channel between nodes is used only once in each direction. By certain switching schedules this capacity could be expanded considerably. For example, assume a simple network connecting four nodes, A, B, C, D.

In the first case, A could send to D, and D could send to A or various other combinations. Also A could send to B, B to C, C to D as well as the same sequence in reverse and simultaneously.

ILLUSTRATIVE NETWORK DESIGNS

The network configurations are based on several assumptions:

1. A leased private line telephone network is provided under AT&T Co.'s common control switching arrangements (CCSA) tariff rates.
   a. New York City, Chicago, and Denver are arbitrarily designated as switching centers.
   b. An arbitrary number of telephone circuits is provided to nodes according to three categories based on size (number of schools served, student population, activities, etc.).
2. A leased private line network of 150 baud data channels is provided under rates and provisions of AT&T Co.'s private line tariff.
   a. A single EDUCOM computer control center is arbitrarily located in Michigan.
   b. All nodes are connected to the control center via a number of 150 baud channels arbitrarily

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assigned according to three categories as described in 1. b. above.

3. AT&T Co. TELPAK rates and provisions are utilized where applicable. Otherwise, rates for individual channels are used.
   a. Both telephone grade channels and 150 baud channels are included in TELPAK at the ratio of:

TELPAK A	12 voice or	48-150 baud
TELPAK B	24 voice or	96-150 baud
TELPAK C	60 voice or	240-150 baud
TELPAK D	240 voice or	960-150 baud

   Combinations of the above channels are included in TELPAK channels in the ratio of 4-150 baud channels per voice grade channel.
4. All nodes on the network are connected by two-way color video channels provided under AT&T Co.'s video tariff rates (commercial).
5. Rates applied to this network include interexchange channel, channel terminal, connecting arrangements, local channel, and CCSA switching charges. Terminal equipment such as teletypewriters, telephone sets, and PBX connecting arrangements are not included in this configuration.
6. This network configuration is provided in two phases: This list gives the total number of telephone and teletype channels operating simultaneously.

Phase I Nodes	Number of Telephone Channels	Number of Teletype Channels
New York	12	20
Boston	12	20
Chicago	12	20
Berkeley	12	20
Los Angeles	12	20
Washington, D. C.	12	20
Ann Arbor	12	20
St. Louis	8	12
Kansas City	8	12
Salt Lake City	8	12
Denver	8	12
Cleveland	8	12

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Phase I Nodes	Number of Telephone Channels	Number of Teletype Channels
Pittsburgh	8	12
Philadelphia	8	12
Phoenix	8	12

(In addition to Phase I Nodes)

Phase II Nodes	Number of Telephone Channels	Number of Teletype Channels
Tulsa	4	6
Dallas	4	6
Houston	4	6
New Orleans	4	6
Cincinnati	4	6
Indianapolis	4	6
Seattle	4	6
Portland	4	6
Detroit	4	6
Buffalo	4	6
Columbus, Ohio	4	6
Raleigh	4	6
Atlanta	4	6
Tallahassee	4	6
Minneapolis	4	6
Madison	4	6

Table 6-8. Cost of Phase I

Costs	Monthly Charges	
TELPAK		
MILEAGE charges	$ 76,710	
(472) channel terminals—telephone	7,080	
(272) channel terminals—teletype	4,080	
		$ 87,870

Table 6-8—Continued

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Costs	Monthly Charges	
CCSA		
(32) local access lines	$ 800	
(120) interexchange access lines	3,000	
(100) trunk terminals	3,000	
(3) selective routing arrangements	360	
		$ 7,160
150 Baud Channels		
(432) station arrangements	10,800	
		10,800
Circuits NOT in TELPAK		
Mileage	5,155	
Channel terminals	188	
Local channels	188	
		5,531
		$111,361
VIDEO		
Channels	331,946	
Station Connections 30 @ $640	19,200	
Local Channels 30 @ $575	17,250	
Color Connections 30 @ $450	13,500	
AUDIO		
Channels	36,084	
Station Connections 30 @ $66	1,980	
Local Channels 30 @ $20	600	
	$ 420,560	
TOTAL MONTHLY CHARGES:		$531,921
Summary Annual Costs:		
TELPAK	$1,330,000	
Video-Audio	5,040,000	
	$6,370,000	

Table 6-9. Cost of Phase II

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Costs	Monthly Charges	
TELPAK		
MILEAGE	$ 155,439	
(528) Channel terminals—telephone	7,920	
(644) Channel terminals—teletype	9,060	
		$ 172,419
CCSA		
(32) Local access lines	800	
(184) Interexchange access lines	4,600	
(160) Trunk terms	4,800	
(3) Selective routing arrangements	360	
		10,560
150 Baud Channel		
(644) Station arrangements	16,100	
		16,100
Circuits not in TELPAK		
Mileage	10,374	
Channel terminals	225	
Local channels	225	
		10,824
		$ 209,903

Table 6-9—Continued

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Costs	Monthly Charges	
VIDEO		
Channels	$ 624,344	
64 Station connections	40,960	
64 Local channels	36,800	
64 Color connections	28,800	
		$ 731,004
AUDIO		
Channels	73,756	
64 Station connections	4,344	
64 Local channels	1,280	
		79,380
		$ 810,384
TOTAL MONTHLY CHARGES:		$1,019,287
Summary Phase II Annual Costs:		
TELPAK	$ 2,508,000	
Video-Audio	9,720,000	
	$12,228,000	

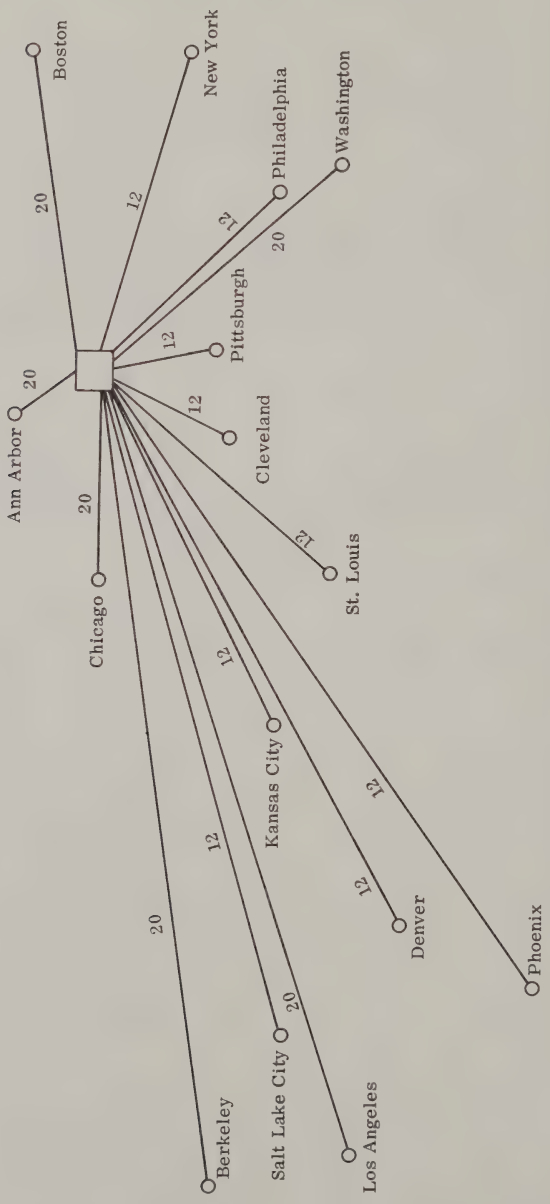

Figure 6-8. Phase I Data Network (150 Baud Channels)

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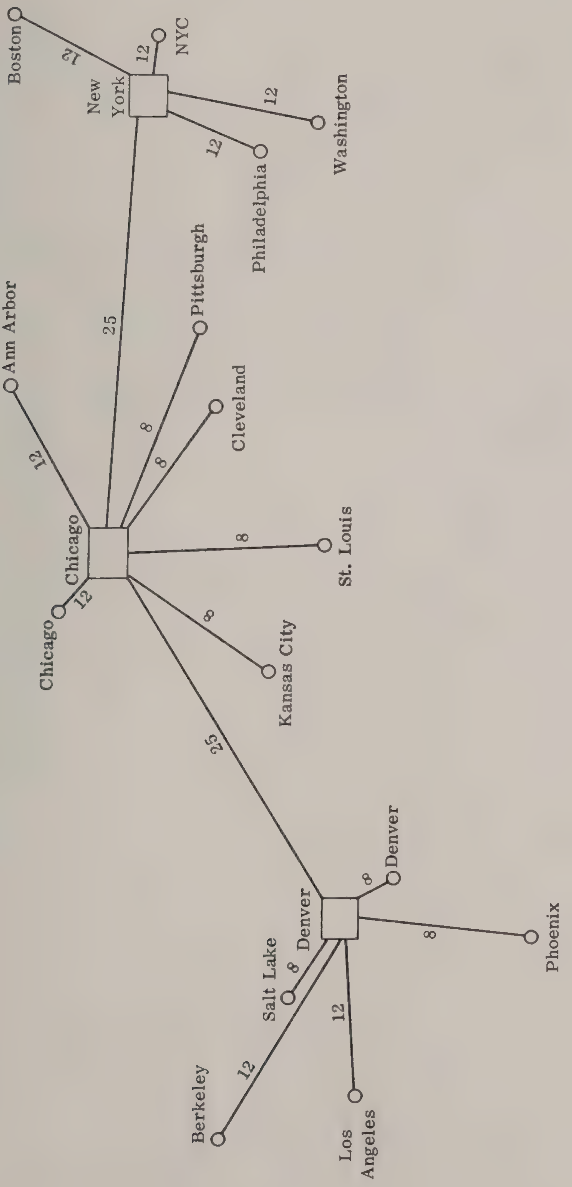

Figure 6-9. Phase I Dial Telephone Network

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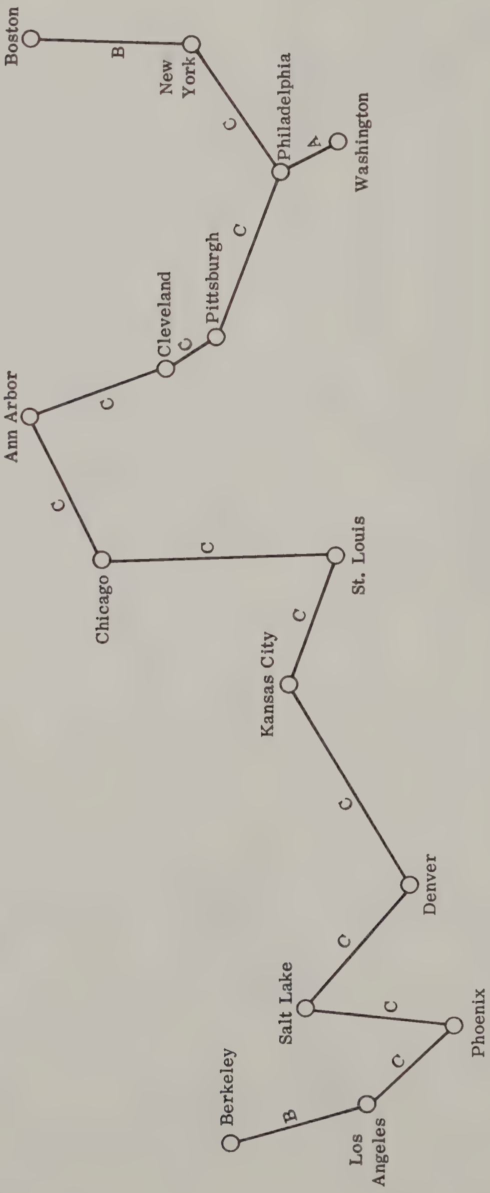

Figure 6-10. Phase I TELPAK

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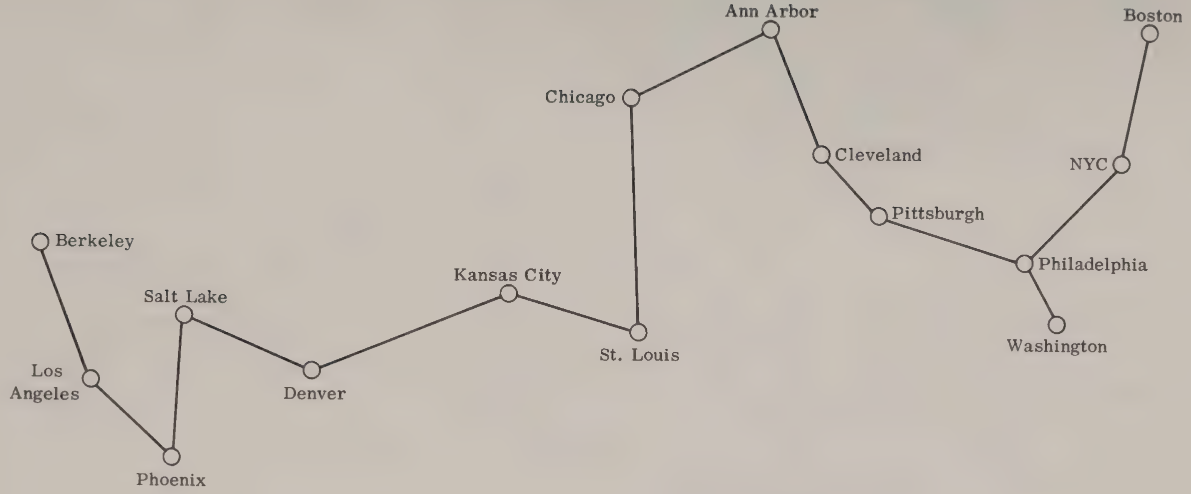

Figure 6-11. Phase I Video Network

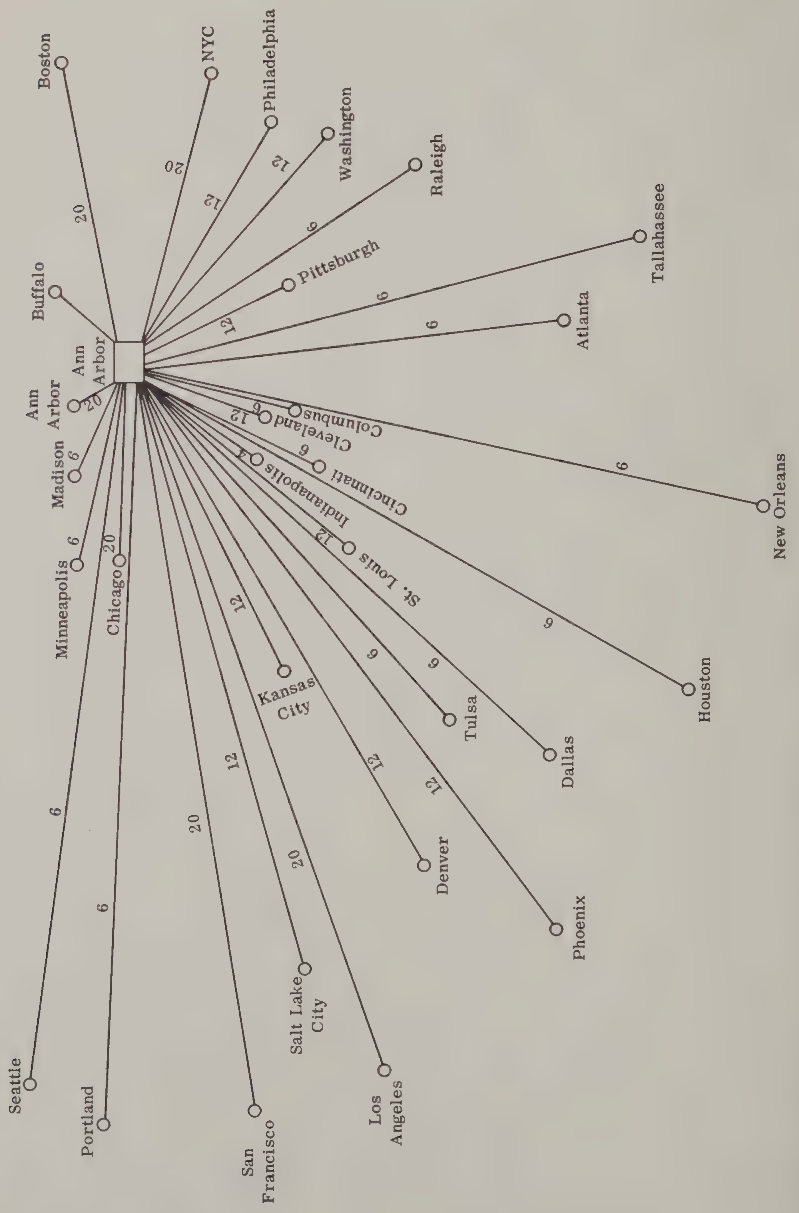

Figure 6-12. Phase II Data Network (150 Baud Channels)

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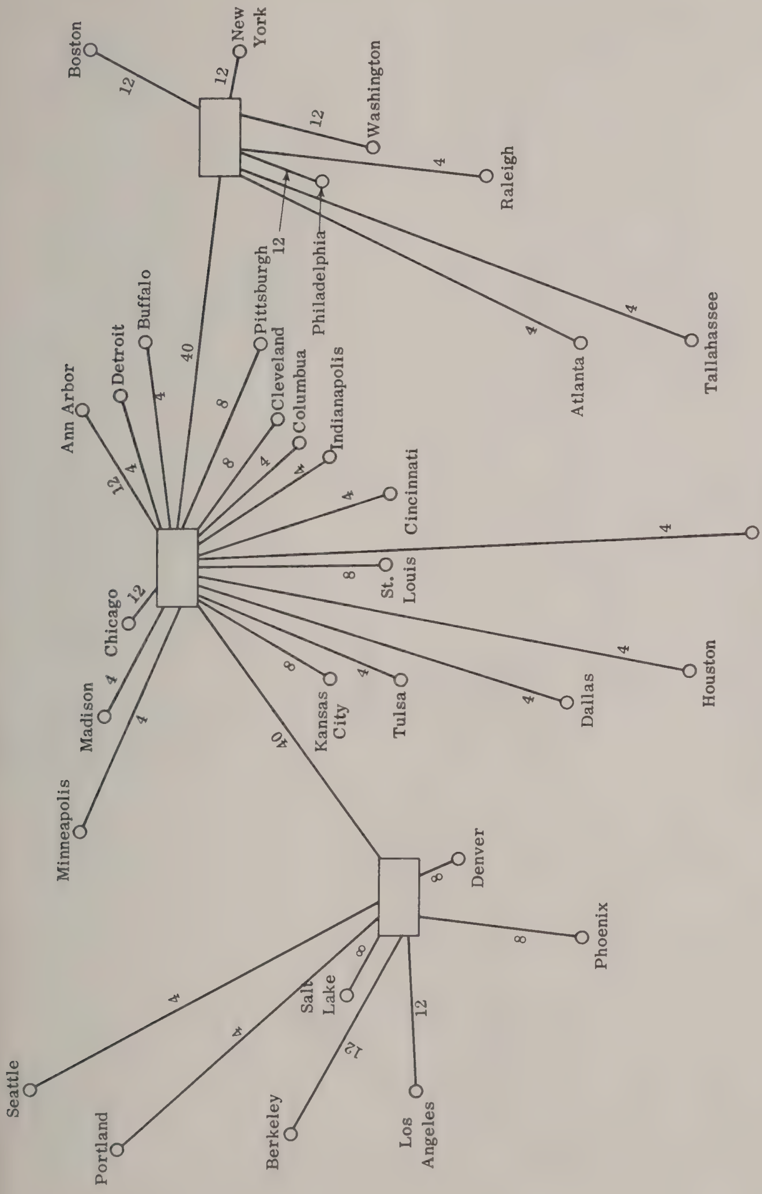

Figure 6-13. Phase II Dial Telephone Network

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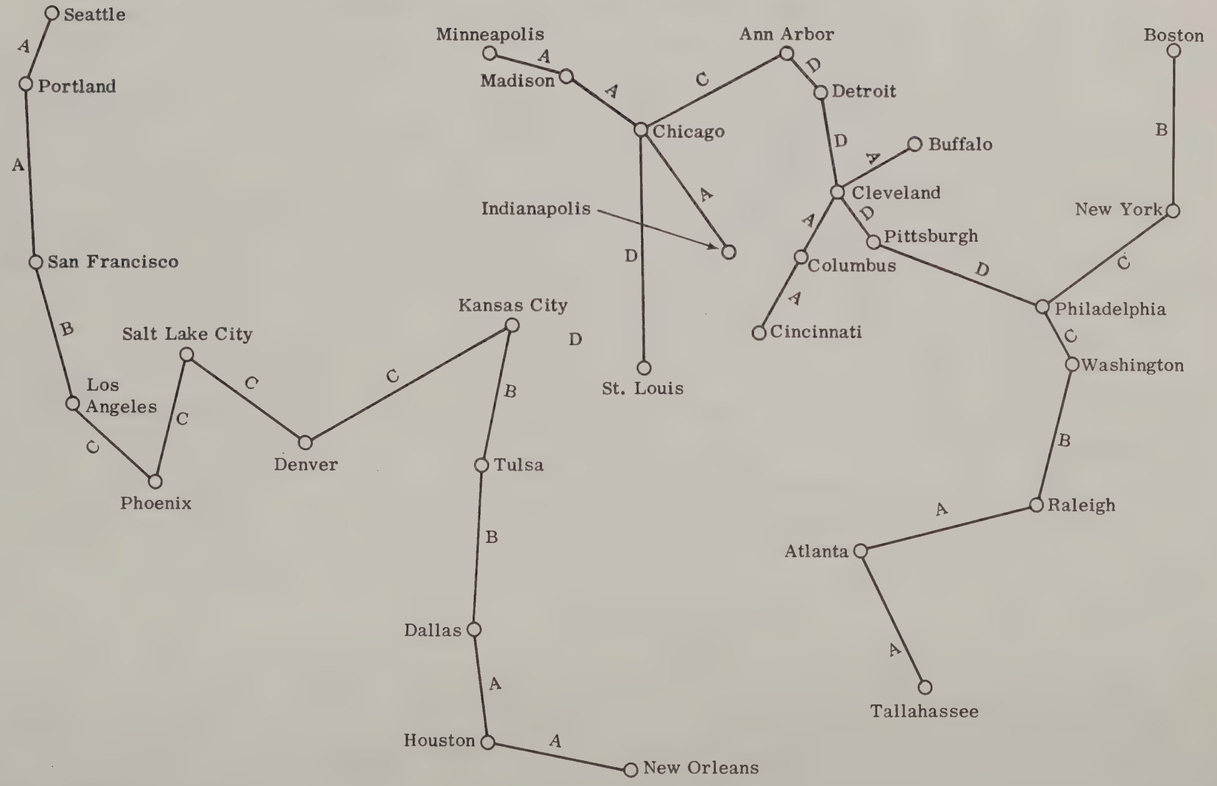

Figure 6-14. Phase II TELPAK

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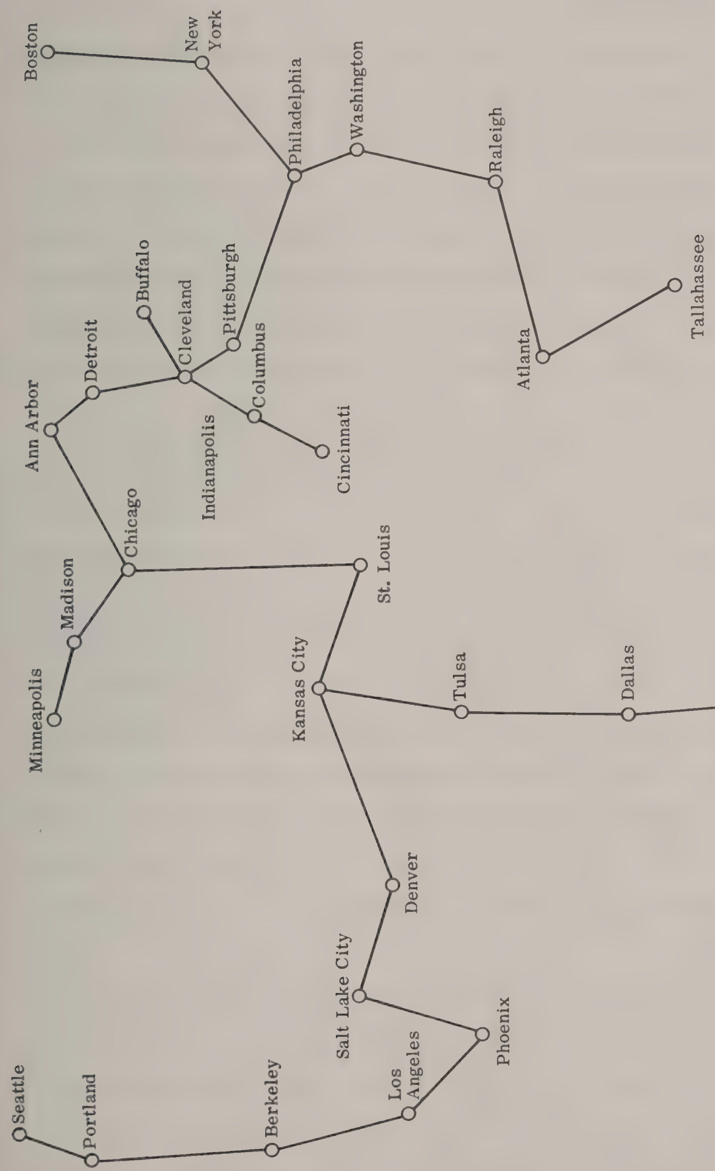

Figure 6-15. Phase II Video Network

VII. EVALUATION

It is most difficult to determine what, if anything, exists to be evaluated, in the way of system designs. First, with respect to the kernel net, comparisons of the "A" and "B" proposals, set forth above, indicated that costs of storage and processing versus costs of communication would determine the question of centralized versus decentralized directories. There were other indications that the particular communications configuration might not be as crucial as some had thought.

XV
Summary
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> The answers to at least two questions seem to be necessary before implementation of any network concept:
>
> 1. What are the nodes (i.e., the institutions to be included immediately), and what are the next ones to be added?
> 2. What are the work loads (types of information and volume) expected for the system?
>
> The preparation and implementation of the *Directory* portion of a system appears to be the most important element, rather than the structure of the network itself.

Together, the above statements may be taken to mean that the problem of network design has reached an impasse, or simply that a great deal of designing still remains to be done. At this point it would seem more important to determine the character of operations at a switching node than to fix its geographical location.

Also to the point of this discussion was Rubinoff's observation that current, real-time, remote-access, time-shared, computer systems may easily require annual operating budgets of several millions of dollars *each*. Put several of these in a network, add the costs of terminal equipment on a reasonable scale, include the costs of applications software and data preparation efforts; the cost of the national communications, at least as estimated so far, then becomes relatively small in the whole picture. As a side remark, the EDUNET and EDUCOM organizations to go with the picture can tolerate fair-sized budgets before overhead ratios become too burdensome.

At this point it may be worthwhile to attempt to appraise progress made by the Summer Study toward the goal of designing a network. One could hardly say that one cycle through the design progress had been completed. At best, it might be claimed that some of the stages had been moved a fraction of the way toward a first approximation of the result of a first cycle. The outcome of the proposal writing efforts initiated at the conclusion of the Summer Study will furnish a better basis for judgment, of course, but it seems reasonable to assert that a substantial area of common interest was agreed upon, a fair notion of the kinds of central services needed was obtained, a much improved picture of EDUCOM responsibilities and roles was generated, a start was made in grouping applications according to their functional character and their promise for early implementation, and a feeling was acquired for the nature of the job ahead.

7

EDUNET

The Summer Study labored, as we have described, and brought forth a plan for EDUNET. This last chapter presents the resultant proposal of the summer's interactions, which began as a large, wide-ranging survey of a vast terrain and focused progressively more sharply upon a single concept of a network. There was never agreement on all details, but there was an unexpected, almost unanimous, consensus by the end of the Summer Study on the need for, desirability of, and essential characteristics of EDUNET. These agreed-upon elements are presented in this chapter, which is a proposal for continuing activity. We ask support to develop a program into operation, not simply to begin planning.

I. THE NEED FOR A COAST-TO-COAST INTERUNIVERSITY INFORMATION NETWORK

The Interuniversity Communications Council (EDUCOM) proposes to establish an EDUCOM pilot network. It will be used for research and development, but it will also provide from the outset a new asset in the educational system of the nation. Our proposal calls for a network with multiple media information-processing capabilities.* Such a pilot network will enable us to take a hard look at how such networks can assist education, particularly higher education. What are the educational functions to which networks can make significant contributions? Can networks fit within reasonable budgets and provide necessary services? Can networks achieve important savings in time, particularly the time of specially trained and qualified experts?

An experimental operation of an educational network is an appropriate function for a consortium of colleges and universities. There is still much to learn about the potentials and problems of such networks. How should the information be formatted, stored, retrieved, and transmitted? How can the information needed by a user be specified? How can the necessary equipment be interfaced with the users?

Complex national and world-wide networks are in use by the United States government for national defense and for the space program. They are in use by industry. For example, airlines have developed extensive and interconnecting on-line reservation services. If networks are demonstrating usefulness in such applications, is it not appropriate to examine the contributions they can make to higher education, scholarship, and science—which are so fundamental to the welfare and improvement of society? There are many who say that the development of interuniversity networks is inevitable. After all, the primary function of colleges and universities is information processing. Information processing, broadly conceived, includes creation of new information (research), transmission of information (teaching), assimilation of information (learning), storage and retrieval of information in libraries and data banks, and communication of information to the society. Administration and management of universities also involve much information processing. Because knowledge is being created faster and in more volume than ever before, educational institutions are faced with a true informational overload. The question we must ask is how, at each point in information processing, savings in time or money can be made to serve the purposes of higher education and ultimately of society.

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*The Carnegie Commission on Educational Television has recently proposed the national interconnection of educational television stations in order to facilitate the distribution of public television programs. Its report, however, recognizes the opportunities television may offer to libraries, archives, data processing, and data transmission. Carnegie Commission on Educational Television, Public Television, a Program for Action; Bantam Books, New York, New York, 1967, p. 52 et seq. and p. 41.

At every step in this evaluation, we must determine which of the various media of information processing will be least expensive or most efficient. In some cases, communication will be best achieved when people come together in classrooms, at lectures, or in conferences. In others, it will be best for documents to be hand-carried or sent by ordinary mail or special delivery. Sometimes it will be best to use the telephone, telegraph, or teletype. In still other cases it will be best to use microform, narrow-band electronic transmission, or wide-band television. The central questions to be asked throughout are whether important educational procedures can be carried out better, more efficiently, with less cost in money and trained manpower by an advanced information network than by the traditional means which we are now using. If so, how and why?

A number of reasons why an interuniversity network appears justified are stated below. Perhaps the most important justifications are that networks make possible sharing of informational resources, equalize access to information, facilitate long-distance interpersonal interactions, provide better bibliographical services, make lifesaving information instantaneously available, and decrease production of unused copies of a wide range of informational materials. Also, they can contribute to decreasing copyright infringement and provide information in a format appropriate for the user. They can further play an important role in improving continuing education and decreasing administrative delays in higher education. The total impact of these contributions is such that we believe the proposed experimental operation and evaluation of a pilot interuniversity network is worth what it will cost. The details of our arguments for this belief are as follows:

A. Sharing of Resources

It is less expensive and more efficient for a group of colleges and universities to share common educational facilities than for each separate institution to buy or lease its own. Budgets are limited in every state and throughout the nation. A great deal of information processing needs to be done, and there is only a certain amount of money. How can it best be allocated? Next year the United States government will spend $600,000,000 for libraries.* Much of this will go for bricks and mortar to create more and larger libraries, none of which will have anything like complete collections of books or journals.

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*Statement by the President of the United States establishing the National Advisory Commission on Libraries, September 2, 1966.

All parts of the country are continually falling behind in the percentage of coverage of the published literature which they can afford. The problem of high schools and junior colleges as well as of poor or new colleges and universities is more acute. For example, there are now nine campuses at the University of California. If all the students and faculty members were to get access to libraries equal to that which the students at Berkeley have, the Berkeley library would need to be duplicated at least six times. To do this would cost $40,000,000 per duplication or perhaps $250,000,000 for the present campuses, and the university is still growing. Such a figure is beyond what the people of California are likely to pay. Some sort of sharing of resources is necessary. This could be accomplished by an intercampus or interuniversity network. The $250,000,000 would pay for storing electronically a large fraction of the bibliographical citations, abstracts, and full texts in the entire published literature. This information could then be retrieved at terminals throughout the network.

Human resources are scarce also. With a network the best lectures of leading professors could be available everywhere, either live—with audience feedback—or on television tape. This would constitute a "distributed university." A scholar or a student, by this means, could interact with a much more extensive, vital, and current intellectual community than exists on any one campus. This opportunity to have contact with leading thinkers would tend to raise the general quality of research and education, put emphasis on the advancement of knowledge, and bring the most advanced thinking to all members of the university community. Certainly such innovation has pitfalls, but it has great potentials. Such improved access to information can motivate excellence in learning and scholarship.

Of course television tape can be mailed, and a cost-effectiveness evaluation must be made as between mail and multimedium network, and as between on-line access and transmission of tapes during hours of diminished network use for later access. A wide-band network could transmit live two-way video interaction between, say, a surgical team on one campus and students on other campuses, so that it would not be necessary for freshman and sophomore medical students in two-year medical schools which have no hospital of their own to go without clinical experience.

One way around the present shortage of highly qualified teachers is to develop instructional materials from which students can learn effectively without much teaching. A network could enable students to consult with the more experienced professors when unforeseen problems arise.

A network could make it possible to gain access to data banks, now coming into existence in increasing numbers, on demand. On-line data banks could be continually updated through the network, and the widespread use engendered by the network would make it worthwhile to check and authenticate the contents frequently.

Thus, network could facilitate making the resources of one institution available to others. Universities could share library materials, data banks, computing facilities, instructional programs, laboratory know-how, and--through the preparation of instructional materials, television lectures, and live "teleconferences" (which do not require professors to move physically from their campuses)—the human resources of faculty members.

B. Equalizing Access to Information

The present explosion in higher education demands that the older and better universities contribute to the development of excellence in the less established ones. Students and faculties at the smaller and less wealthy institutions have always had smaller libraries and less adequate access to information than students and faculties at the larger and richer institutions. The availability of information also differs from region to region of the country, being poorer in the South, the mountain areas, and certain other regions than it is, for example, in New England, New York, Washington, Chicago, and San Francisco. This is in a sense not fair, and it is surely not in the public interest. With traditional libraries it would cost too much to correct this disparity. A network, however, could provide much more uniform dissemination of information throughout the country. Simply adding more wings to libraries and buying more books to put in them is not a viable solution. Through a network, small colleges and universities would be able to use the expertise of personnel trained in information processing as well as the hardware and software of large computing facilities that they could not afford to own or lease. We must experiment with more efficient and more egalitarian approaches.

C. Accelerating Information Processing

The concept of the network we are considering is fundamentally different from traditional concepts. We do not yet fully understand either its problems or its potentials. We believe, however, that it would save students and scholars much time and accelerate scholarship throughout the academic world.

Assurance of rapid access to information will make studies feasible that are not feasible now, and make studies attractive that are not attractive now because they would require too much time. (There was a significant increase in the difficulty of problems in computational mathematics and astronomy undertaken by researchers after the advent of computers. We are beginning to see in the on-line computing communities, such as the one at M.I.T., significant changes in the kinds of questions asked and the kinds of research undertaken by the scientists and engineers.) There will certainly be changes in scholarly behavior when citations, abstracts, and full texts can be obtained quickly at remote terminals.

On-demand access to taped television programs, as contrasted with scheduled access to traditional broadcast and closed-circuit programs, will make educational TV more effective.

Programmed graphic aids to problem-solving and design, such as Sutherland's "Sketchpad," will have profound effects on our ways of thinking and working. Sketchpad is a program that enables a user to sketch with a "light pen" complex systems or processes on a cathode ray tube linked to a computer and then to manipulate the systems or processes with the aid of programs and to store the results in the computer for later retrieval. Such capabilities can be made available through networks as soon as the economic obstacles can be overcome. At present, graphical processing by computer is costly—too costly to be afforded generally—but a pilot network will enable us to learn what the real costs and values of such techniques are.

More rapid editing, reviewing, and publication are greatly needed in some fields. With publication lags in scholarly journals commonly nine months to a year, it takes a long time for new work to become widely known and even longer for critical reviews of it to appear. A network might decrease the lag and at the same time improve the processes of screening and editing.

D. *Facilitating Long Distance Interpersonal Interactions*

Much time and money are spent by faculty in traveling to conferences. For some purposes direct face-to-face human interactions are undoubtedly best, and conferences will never disappear. For others, such as periodic committee meetings of university-wide committees in multicampus universities, live "teleconferencing" over a network may provide the necessary communication, be cheaper than travel, and permit the committee members to spend more time on their home campuses. The scarce time of medical specialists, for instance, can be conserved if they do not have to travel to consult about patients with other doctors but can accomplish the same purpose through live teleconferencing.

Under present procedures when two or more persons want to participate in a joint interactive intellectual process, such as jointly writing or editing a manuscript or a computer program, it takes on the average about two weeks to get a single letter of reaction from a colleague. A network could speed up the interaction.

E. *Providing Better Bibliographical Services*

After a network is put into operation, there will be a gradual trend for authors and publishers to learn of it. They will make arrangements so that users can get access to their publications over the network. Eventually a scholar may be reasonably certain of being able to locate from network terminals all references relevant to a given topic, even if their existence is unknown to him. We are far from that with even the best bibliographical services today.

Updating books by publishing successive editions is expensive. Editions of dictionaries and encyclopedias appear every few years; yearbooks of encyclopedias and annual reviews of scientific specialities are published every twelve months. Because they have about a two-year lag, on the average, in providing information, one can be almost certain that the information in them is not up-to-date. In networks which have computerized information storage and retrieval systems and data banks, materials could be kept current within days or hours. If the task of inputting were divided among several individuals or institutions on the net, the costs could be made reasonable for all concerned.

Networks could provide on-line access to machine-readable shared union catalogs. These could tell on demand, in an updated form, where the nearest copy of a desired book is located, on either one's own campus or some other campus. Such information could greatly increase the efficiency of interlibrary loans. Such records of holdings could also make possible much more efficient library management and might avoid undesirable local or regional duplication of books and journals, making many purchases unnecessary. Networks would also cut down significantly the costs of ordering, cataloging, and shelving a journal or book, which amount to a significant fraction of the purchase cost.

With the electronic storage and retrieval of citations, abstracts, and full texts, documents would not be unavailable because they were in use, lost, stolen, or misshelved. As many copies or displays could be provided at one time as there were readers to use them. In present-day good university libraries, as many as 20 percent of books requested are, for one reason or another, not available.

On-line systems which selectively disseminate abstracts or documents to users at remote terminals of a network could be developed. The user first would indicate his personal profile of interests in the scholarly literature. He then automatically would receive selected items over the network. Periodically he would update his interest profile, or it would be updated automatically by a computer from reports he gives on his satisfaction with documents received previously.

The connectivity and switching capability of a network can direct an enquirer to the information he desires or at least to the person who has the information. Much of scholarship involves such searching. The network will make it easier and faster.

F. *Making Lifesaving Information Instantaneously Available*

Medical crises demand that certain sorts of information be available speedily and on demand. Cost becomes almost a secondary consideration when the information may be lifesaving. Rapid access should be provided to data banks of poison control information and drug toxicity information. A hospital records exchange system should speed hospital records over a network to any part of the country as needed, saving precious minutes in emergencies.

G. Decreasing Production of Unused Copies

Networks can save money by eliminating the need to duplicate copies of little-used materials. Copies would not be made until they are requested, and many would never be requested. One copy of anything in electronic storage is enough. Barring accidental destruction, it will always be there. Access will always be possible with the network, and soft copies (displays) or hard copies can be had at any remote terminal, as desired.

Because fewer copies are made, journals might be able financially to publish (or put on the network) a higher percentage of the good articles submitted to them. This would tend to decrease the proliferation of scholarly journals and might lead to better overall organization of publishing activities.

H. Decreasing Copyright Infringement

It may be possible so to control an electronic network that publishers will be confident they can keep track of uses of their copyrighted documents. The output of a network could be more accurately monitored than the output of a duplicating machine. Publishers should be able to put copyrighted materials into a network with confidence that appropriate recompense will be made for their use.

I. Providing Information in a Format Appropriate for the User

Today scholars and students are missing much material relevant to their work because they do not have access to the equipment necessary to process it. A computer program may be written for a machine which is not available to them. A microfiche may not be compatible with their microform reader. They may not be able to get access to a TV tape recorder. A properly operated network may make it possible for a wide range of materials to be transformed to suit the network compatibility standards and consequently make them all available to relatively simple, standard terminals.

J. *Improving Continuing Education*

When a network is in operation, users need not go to training centers. Their training can come to them conveniently where they want it, wherever a remote terminal can be installed, in an office or a home. Consequently such a network can inject new life into programs of continuing lifetime education, in fields as diverse as teacher education, business, engineering, health sciences, physical sciences, and military science.

K. *Decreasing Administrative Delays in Higher Education*

As large organizations like universities grow they frequently develop increasing delays in routing administrative paperwork. This unquestionably decreases their efficiency. The rate of transmittal of personnel, budgeting, planning, and other administrative documents in industry is being accelerated by computers and use of networks with on-line terminals. Computers and networks can be used to good effect both inside universities and in interuniversity exchanges of references, student transcripts, and student records.

L. *Conclusion*

The research and development involved in building and operating a pilot network can be carried out so that it can be tested and evaluated in the proving ground of use. Our proposed network would be operated according to controlled procedures which would guarantee evaluative feedback from the users. There are many hard questions to be asked. They all add up to the question of whether the benefits from a network will be greater than possible drawbacks and whether it will be worth its cost in money and human time.

We have given much consideration to certain possible undesirable effects of EDUNET, if it should be technically successful. It might conceivably be operated so as to infringe the privacy of users or to limit or control their freedom of expression or modes of thought. For instance, a user of a network will want to be able to store information in his private memory bank which he can be certain will be retrieved only by him or with his permission. Such information may be personal, confidential, or not in proper form for publication. An engineer might not wish facts revealed relevant to a patent; a lawyer might not want others to see a draft of a brief he is preparing; a student might not wish a dean to see his health record; a teacher might not want the scoring key to an examination to be publically available; a dean might not want a professor to see reference letters in his file relevant to that professor's promotion. The system must provide guarantees that no one can get access to information he is not entitled to see. It must also do its best to prevent personal biases of any person or group from distorting or restricting the flow of any information. And there must be no improper constraints upon who within EDUCOM institutions can get access to nonprivate information—regardless of his political views, personality, age, experience, or whether he belongs to a public or private educational institution. The freedom to use the network within cooperating institutions should be comparable to the freedom to use the mails. Access to it will become important to the exercise of academic freedom in the colleges and universities of the future.

Consideration should also be given to the subtle question of possible undesirable effects from the close coupling together of individuals and campuses which the network could provide. Will rapid and efficient access on demand to the same store of knowledge result in too great homogenization of academic thought and suppress diversity and individualism? Will the use of the same computer languages and programs have a similar effect?

We think there are technical, procedural, legal, or ethical solutions to such problems. But EDUCOM believes it would be irresponsible to propose a technological innovation in education and science, with the possibility of major impact for good or ill, without seriously considering issues like those outlined above. Its Board of Trustees, therefore, has requested its Task Force on Legal and Related Issues to consider ethical and legal matters like these raised above, along with such other problems as copyrights; patents; contracts; allocation of communications frequencies; rates and regulations for use of long lines, microwave, satellites; negligence; and possible antitrust actions. We expect that the EDUNET staff would have one or more lawyers concerned with the wide range of such matters which will surely arise.

All relevant surveys indicate that institutions of higher education will in the future greatly expand their use of information processing technologies. Just how this can best be done is not clear. What services will be profitable and in exactly what order they should be implemented are not clear either. In this proposal we mention a number of such services and even suggest a rough priority in which they might be implemented. Certainly it will take a long time to implement all that are possible, and a phased program is required.

The essence of this proposal is not to spell out such a phased program, but to recommend the establishment of a permanent staff for an interuniversity project to design and operate a pilot network. It will do the work necessary to find rational answers to the very difficult questions of what services to make available on the network, and in what order. The services mentioned in this proposal are to be viewed merely as examples.

It is difficult also to predict what the ultimate outcome of the experiment we propose will be. EDUCOM at present is requesting support to undertake a research and development activity to design and evaluate a pilot network. The effort should be large enough to provide enough services for long enough to make an impact on the users and their colleges and universities. A lesser effort would make the evaluation meaningless.

When this purpose is accomplished, it is unlikely that the activity will simply end and be reported as a valuable experience. It more likely will develop into a permanent operational system. The ultimate network might possibly be operated by government or industry rather than the universities; but all sectors of the society can learn from the experiment, which will be conducted and reported publically in the tradition of the universities, so all can profit from it.

By the end of the experiment some users may well have become dependent on the services provided. Certainly the EDUCOM colleges and universities will not lightly or irresponsibly, suddenly cease providing such services unless some other agency takes them on. But the universities have plenty to do now, and they would very likely prefer some other sector of the society—say industry—to provide the services, if the cost was reasonable, if there were no biases or constraints on the information and services, and if their quality, speed, and accuracy were satisfactory.

No one denies that the educational and scientific processes are central to the welfare and progress of our society. Many believe that the new information technologies can importantly improve these processes. The cautious and constructive way to discover whether this faith is justified is to carry out a controlled pilot study of sufficient magnitude to be significant and reliable. We shall learn whether the system devised is viable and valuable while we are operating it.

II. TECHNICAL PLANS FOR A NETWORK

A. *Summer Study Conclusions Relevant to EDUNET*

The major conclusions of the EDUCOM Summer Study relevant to the proposal that EDUCOM universities undertake the establishment and evaluation of a pilot EDUNET, may be recapitulated as follows:

1. In the near term a network will be needed to make possible efficient sharing without unnecessary duplication of their educational resources.
2. A resource-sharing interuniversity network is technically feasible.
3. In many areas the cooperative sharing of resources can reduce duplication and improve educational programs and services, advance research, prevent

inadvertent duplication of effort, and reduce costs of many academic activities.

4. The initial network should be a pilot network but of sufficient scope to permit meaningful evaluation.
5. The plans laid during the Summer Study have to be sharpened in respect to how, where, and when the network operations will be carried out. Many aspects must be developed in technical detail.
6. A suprauniversity organization with research and development facilities is required to complete the detailed planning of the network, to develop it, and to operate it.
7. EDUCOM universities are prepared jointly to establish the necessary decentralized laboratory and through it to carry out the systems design and other research, development, and operational tasks involved in setting up, running, testing, and evaluating EDUNET.
8. The suprauniversity organization must have a strong, dedicated, full-time, technical working capability as well as a strong administration. It must establish research and development units.

B. Approach to the Implementation of a Pilot EDUNET

In collaboration with member universities, EDUCOM proposes to establish an EDUNET laboratory made up of three or four integrated but geographically dispersed branches. This laboratory will plan, design, operate, and help in the evaluation of the pilot EDUNET. It will compare the various alternate approaches to the desired ends; determine performance specifications of the network; plan, determine the sequence, and assign responsibility for the specific tasks which must be carried out before the network can operate; decide how many persons and what time are required to perform these tasks; and determine how to keep account of and evaluate progress toward the desired ends. In particular, the EDUNET laboratory will fulfill the following functions:

1. Determining what services will be provided by EDUNET.
2. Designing, selecting, and testing equipment and configurations of equipment to make up the pilot network.
3. Determining the requirements of EDUNET compatibility, *i.e.*, the structural and functional specifications for hardware, software, and procedures of EDUNET. C. W. Sherwin, Deputy Assistant Secretary of Commerce for Science and Technology, has pointed out the central role of compatibility standards in the development of present national and international railroad, telephone, and electric power networks. He said that "...the identification and adoption of common standards was the *sine qua non* of the system development. Well selected standards impose a minimum degree of central control and a maximum amount of common advantage. Although the information-using communities are much more diversified than those involved in any of the three examples listed above, it is nonetheless true, as we shall show, that the adoption of common standards will have a similar effect. Our problem has three stages: (a) identify a minimum set of basic standards, (b) find a practical method for implementing their use, and (c) estimate the costs and benefits of such use."

Among the most important functions of the EDUNET laboratory will be the establishing of national standards of compatibility. A neutral, objective, nonprofit organization representing the universities may be able to bring about agreement among profit-making industrial corporations when they would be unable to do it among themselves or perhaps be unwilling to do so because of antitrust laws. Among networks serving local areas and regions of the country the EDUNET laboratory may also bring about agreements on standards. While premature attempts to achieve compatibility can result in poor decisions based on inadequate understanding of the problem, postponing such decisions can be costly. The EDUNET laboratory can play a role in making decisions which can make compatible the regional networks in which EDUCOM universities are involved, like those mentioned later in this proposal. A national system, like EDUNET, in addition to preventing incompatibility among regional networks, could call upon expertise from many parts of the country and would demonstrate clearly that a national system is feasible.

(Within EDUNET, up to an interface with the user, compatibility must be maintained. The user, on his side of the interface, is free to employ whatever hardware, software, format, and procedure he wishes—so long as the signals and messages he transmits through the interface meet the EDUNET conventions and standards. Questions of hardware compatibility include standards on such matters as number of bits used to represent an alpha-numeric character, size of the character set, rate of transmission, and number of lines per television scan. Questions of software compatibility include standards on such matters as system command vocabulary, methods of identifying users, programming languages, file structures for computers storing information in memories, format of library catalog cards, format of patient records, and format of accounting records concerning EDUNET operation.)

4. Writing and debugging software systems essential to the operation of the pilot network and the use of its services.
5. Indexing and maintaining an on-line directory to the services and materials available through EDUNET, with information on how to obtain and use them and what they cost.
6. Switching, *i.e.*, putting the user on-line to the services or materials he wants, whether they are located near him or far away.
7. Maintaining records of use and accounting for costs.

(Examples of records to be kept include identification of the user and his institution, identification and measure of the service or information used, how much time he spent at it, and to whom the service should be charged. Once the service is operating effectively, the individuals or institutions that use it will make an appropriate payment for it. Accounting, of course, covers determining the costs for each service, allocating the costs to the various accounts, billing each use, and collecting. Records must be maintained over a period of trial and experimentation with various services to provide a basis for establishing appropriate charges.)

8. Evaluation of the usefulness of EDUNET and determination of the degree of satisfaction of users in relation to cost.

(In order to make such evaluations it will be necessary to record, in addition to the information needed for accounting, the amount of time delay before the services are received; the amount of time required for the complete service; the user's interest patterns, position in the university, department, and college, or campus; some measure of his satisfaction or dissatisfaction; and his reasons for satisfaction or dissatisfaction. From such information it will be possible to analyze traffic patterns of information; measure the accuracy of different services; determine the value and popularity of various services provided by EDUNET; learn the distributions of frequency of usage among different classes of users; and discover ways to improve services and eliminate inefficient or costly procedures.)

The laboratory branches will become the prime nodes of the pilot network as it is developed, so that their experience and expertise will be available to all users of the pilot network. In short, the EDUNET laboratory is to be the backbone of the pilot EDUNET.

EDUCOM is therefore eager to:

1. Establish EDUNET laboratory branches for the effective execution of research and development of activities in the planning, design, testing, and selection of hardware, software, and data bases which are needed to make EDUNET operable.

2. Administer grants or contracts to fund the research and development programs of the EDUNET laboratory, and
3. Establish a pilot communications network including the branches of the EDUNET laboratory and EDUCOM universities.

C. *Description of a Pilot EDUNET*

The Summer Study made clear the need to develop EDUNET in progressively planned phases. It recommended that EDUCOM proceed initially on a pilot basis in order to demonstrate the advantages and benefits which member universities will derive by using such a network. Consequently, EDUCOM proposes to begin with a limited network operation that is designed to provide appropriate means for studying and testing many of the technical aspects of a larger, more extensive coast-to-coast EDUNET. This model will allow EDUCOM to determine the practicality of selected designs and procedures, to establish relative performance criteria and standards, and to gain experience with the economic and management problems that are certain to develop.

To minimize the cost of the pilot EDUNET and bring it within a practical range, funds are now being requested to operate only a kernel network. This will interconnect only the EDUNET laboratory branches and the switches (see below). Most of the cost of providing input will be borne by the sources which prepare it in machine-readable form. If the cost of preparing this were included in this proposal, the budget would have to be several times what is requested. Another major saving will come from having participant universities pay the long-line charges from the nearest EDUNET laboratory branch or switch to their campuses, as well as the cost of whatever number of terminals they choose to use. They will also pay a service charge for all EDUNET services. By this strategy of spreading the costs of input and output to other agencies, the budget for the kernel EDUNET can be kept relatively small.

We have established criteria for planning a pilot network. EDUNET should be:

1. Sufficiently extensive to permit access to it by an appreciable part of the academic community. (Access, in this instance, is defined as the ability of an individual on a college or university campus to obtain information from EDUNET through a terminal device.)
2. Capable of serving a diversity of applications, so that it will stimulate trial use and evaluation in many disciplinary areas.
3. Constructed to provide EDUCOM colleges and universities with a full range of communications experience with multiple media--digital and analog, voice and video.
4. Expandable in order to accommodate continued growth.

Based on these criteria, the plans for a pilot EDUNET are as follows:

1. EDUNET will include at least three and perhaps four principal EDUCOM facilities called EDUNET laboratory branches. In addition any EDUCOM college or university may, if it wishes, establish its own EDUNET laboratory branch if it has:

a. A faculty INTRACOM committee, made up of educators and administrators interested in the various information processing media, to determine answers to such questions as: the location of terminals on campus; the nature of the interconnections between EDUNET and the local campus computer(s), radio and television services, libraries, and other information processing activities; priorities of materials and services to be derived from EDUNET and put into EDUNET; priorities among users and usages of EDUNET on the campus; how the various EDUNET services will be employed in the activities of the university; and how the services will be paid for.

b. A director for this EDUNET laboratory branch who is mutually acceptable to the college or university and to the EDUCOM Board of Trustees.

c. Sufficient space.

d. Money to finance its activities.

e. Projects of relevance and interest to the entire EDUCOM network.

Each EDUCOM laboratory branch will devote itself to the welfare of the entire EDUNET. Each EDUCOM university is also free, of course, to establish any form of local organization it wishes for arranging its own use of the services and materials of EDUNET and for offering services or materials to EDUNET for review and possible inclusion in the EDUNET repertoire.

2. The EDUNET laboratory branches to be established and funded under this proposal will be located and operated as follows:

a. Located in the Research Triangle in North Carolina and operated cooperatively by Duke University, North Carolina State University, and the University of North Carolina at Chapel Hill.

b. Located at Ann Arbor, Michigan, and operated cooperatively by a group of universities including Akron State University, Cleveland State University, Kent State University, Michigan State University, the University of Michigan, Wayne State University, and Western Reserve University.

c. Located at a University of California campus in Southern California (the location at present being under negotiation) and operated jointly by all the campuses of the University of California.

d. Perhaps also located at some other center in the East or Northeast and operated by a group of eastern universities.

The EDUNET branches will be connected by leased channels and by supplementary circuits paid for on a message-by-message basis. Through the branches and additional switching arrangements, EDUNET will interconnect EDUCOM universities, colleges, and other cooperating organizations across the country.

Organizing and operating the geographically distributed EDUNET laboratory will be somewhat costlier than organizing and operating a laboratory at a single location, but the approach based on distributed branches under unified management has a number of advantages:

a. It demonstrates from the outset that the distance from coast to coast is not an overwhelming obstacle to network operation. Calculations made during the EDUCOM Summer Study showed that the cost of long lines, including coast-to-coast channels, will probably not be more than 10 percent of the cost of the overall system. It is important to note that much of the cost of electrical transmission is associated with switching and that the toll for 3000 miles is far less than 30 times the toll for 100 miles.

b. It makes possible the operation of a fully generalized network. Beginning with a few dispersed branches will enable EDUCOM to experiment with actual problems of network arrangement and operation. With a single center or with two centers the problems would not be met in full generality, but with three or more nodal branches EDUCOM could work on the essential problems of a full-fledged network.

c. It permits EDUCOM to take advantage of geographically distributed capabilities—the special talents and the unduplicated educational resources of the communities in which the EDUNET laboratories are to be located.

d. It provides for the development of further capabilities—EDUNET staffs and facilities—in several geographical areas, conveniently available to potential users.

The pilot network will be designed:

a. To provide information and communication required to augment academic instruction, research, services, and administration.

b. To be extendable to other institutions if the initial network proves itself.

c. To take advantage of satellite communication when and if such technology turns out to be available and advantageous.

d. To provide experience in both long and short distance communication.

e. To provide experience in mixing of scheduled and unscheduled network operations.

f. To yield data for evaluation.

3. Each branch of the EDUNET laboratory will have a computer, equipped with direct-access files and with devices to connect the computers with communication channels.
4. In addition to the EDUNET laboratory branches, several EDUNET switches will be included in the kernel EDUNET. To link each participating organization with all the others through private lines would, of course, be too expensive. The linking will be accomplished with the aid of switchable channels. The switching points will be the EDUNET laboratory branches and the EDUNET switches. The main purpose of the latter will be to provide an economic and convenient way for EDUCOM universities other than those near EDUNET laboratory branches to gain access to EDUNET. Users at such universities will be able to reach switches from several types of terminals through common carrier, leased, or private lines. EDUNET switches may be equipped with small computers to implement network procedures, such as user identification, accounting, and

route selection; there will be directories to files but no substantive information files at the switches. EDUNET switches will probably be located at Denver, Chicago, Pittsburgh, and Boston. The switches will be capable of both line switching (the kind of switching employed in setting up a telephone call) and message switching (receiving a message and the address to which it is directed, storing them until an appropriate channel is available, and then transmitting them to another location nearer the destination—hence, "store and forward"). We do not yet know enough about the operation of a switch to know whether it will require a person in attendance at all times or can be completely automated.

5. EDUNET will be developed in three phases:
   a. *Phase I, May 1967 through June 1968*—Establishment of the EDUNET laboratory branches and detailed planning of a narrow-band pilot EDUNET. During this period the EDUNET organization will be established. The director of EDUNET and its laboratory, the directors of the EDUNET laboratory branches and their staffs, will be selected. The necessary space and other facilities will be obtained. Extensions in detail of the plans made at Boulder will be made, *e.g.*: exactly what lines will be leased, and from what companies. Similarly, what computers, memories, terminals, and other hardware will be needed for the EDUNET, its laboratory branches, and its switches? Explicit statement of initial standards of EDUNET compatibility. Initial

design of systems programs. Specifically what data banks, reference materials, documents, instructional programs, and radio and TV programs will be made available through EDUNET, and in what order? How will the foregoing be obtained or prepared? How will they be indexed? Procedures for indexing and switching. Administrative organization and procedures. How EDUNET operations will be evaluated. How costs of operating EDUNET will be calculated, accounted, and allocated to sources of support.

During Phase I, if planning advances faster than high-calibre staff can be recruited, some design and programming will be contracted out to competent commercial or nonprofit organizations, but the contracted activities will be kept under close supervision by the director of EDUNET and his staff.

b. *Phase IIA, July 1968 through December 1968*—Installation and testing of narrow-band pilot EDUNET.

c. *Phase IIB, January 1969 through June 1969*--Operation and extension to EDUCOM universities and participating organizations of narrow-band pilot EDUNET, and preliminary planning of wide-band pilot EDUNET.

d. *Phase IIIA, July 1969 through December 1969*—Continued operation of narrow-band pilot EDUNET and installation and testing of wide-band pilot EDUNET.

e. *Phase IIIB, January 1970 through June 1970*—Operation and extension of wide-band pilot EDUNET to EDUCOM universities and participating organizations.

Some of the channels of communication which will ultimately link EDUNET laboratory branches and the universities and other organizations participating in EDUNET will be adequate for full duplex color TV, thus allowing for broad-band communications to be carried on simultaneously in two directions. Although it is expected that lines leased from the Bell Telephone System or Western Union will be used in Phases I, II, and III, studies will be carried out during those phases to assess the desirability of EDUCOM's owning some of its own links in order to test their relative effectiveness and cost. Those studies will be made in an EDUNET laboratory branch associated with a university that is active in educational television and in association with one, or more than one, educational television station.

6. For the wide-band communication of Phases II and III, leasing of lines from the Bell Telephone System or Western Union was decided upon rather than independently engineering and constructing the necessary links, for the following reasons:
   a. Leased service can be obtained soon after plans are made firm, whereas construction of microwave links might take several years.
   b. Some time after 1970, long-distance transmission by satellites may become advantageous for EDUCOM's purposes and of great importance to EDUNET. It would probably be a mistake for EDUCOM in the interim to put much money into microwave links, which might turn out to have less capacity and be more expensive than satellite links. For

EDUCOM, the preferred uses of satellites are multimedium uses and to a large extent interactive (bidirectional) uses; they are not limited to broadcast television.

Joint operation of an EDUCOM TELPAK system for ordinary long-distance telephone calls is now being studied by the American Telephone and Telegraph Company. Calculations are being made as to whether such a system will bring worthwhile savings in the unit costs of long-distance telephone calls among the EDUCOM universities. This is an important first step toward EDUNET. Later steps will deal with other classes of communication and other informational services.

7. A terminal may be an electric typewriter, a teletypewriter, a graphic display device, a facsimile sender or receiver, a radio or TV transmitter or receiver, a line printer, a magnetic tape unit, or any other standard input-output device. Students, faculty, research workers, clinicians, administrators, computer centers, libraries, educational radio and TV stations, and university hospitals will be able to enter EDUNET through input terminals that meet EDUNET interface specifications. Terminals operated by members of EDUCOM universities and colleges will have direct access to EDUNET files of data either by going through an EDUNET laboratory branch or switch or by using a private line or an ordinary telephone line. Through EDUNET, users ultimately will be able to exchange notes or papers with one another through graphic facsimile transmission, procure printed articles from books and

journals in distant libraries, hold teleconferences with colleagues at other locations, employ educational TV in classroom or laboratory instruction, participate in computer-assisted instruction, or forward and analyze analog data.

8. EDUNET will be used by the EDUNET laboratory branches, the EDUCOM colleges and universities, the sponsoring agencies which fund this proposal, and perhaps other organizations. The regional network systems currently being developed under state and federal programs will be able to arrange to use EDUNET. Many of these programs have close ties with EDUCOM universities. Through interconnection of networks, it will be possible to share files and other resources to mutual benefit.
9. Every EDUCOM campus will have access to EDUNET. Each campus is being urged to organize an INTRACOM or similar committee, to carry out such functions as:
    - a. Determining how to coordinate the various informational media, materials, and services with the educational, research, and administrative activities of the campus, the college, and the department.
    - b. Finding financial support for planned activities.
    - c. Planning and—if they are not already available—obtaining the local equipment (computers, terminals, television apparatus, etc.) that will interface with EDUNET.
    - d. Planning and implementing the connection of local facilities to the EDUNET interface.

e. Determining how to evaluate EDUNET in terms of local educational goals.

f. Organizing the research and development activities required to provide new or improved applications, materials, or services for EDUNET.

g. Establishing training and research programs in the systems, information, and communication sciences.

EDUCOM is fully aware that the pilot EDUNET must be effectively protected against overloads, especially overloads from misuse occasioned by inexperience. Protection against overloads can be achieved by limiting the number of users or the amount of use per user. Priorities can be assigned for each EDUNET service to particular individual users or to particular campuses. The EDUNET staff and the EDUCOM universities will experiment with methods for avoiding and for handling overloads. Some of the studies will involve actual network operations; others will involve simulations.

By the end of Phase IIIB, EDUNET will be providing its users on demand at EDUCOM campuses with a wide range of services relevant to the interests of many disciplines, services employing all the information-processing media which continually increase in number and depth and variety of content as well as sophistication of organization.

D. *EDUNET as Seen by a User*

How will EDUNET look to its users? The following illustration is intended to convey an impression. It deals with services which might not be available in 1969, but could be by 1970. It mentions, however, only a few of the facilities that EDUNET will ultimately provide. Nor does it describe the only way the particular facilities described will be used. The illustration uses arbitrarily selected specifics in the interest of clear visualization.

Professor Mocude at Erehwyna University needs to examine the file of current research activities. The file is maintained by the Ann Arbor Branch of the EDUNET laboratory. Mocude wants to know who is working on cardiovascular reactions to anoxia. He goes to a typewriter terminal in his secretary's office, and dials a local number, 846-9203, which connects him into EDUNET.

The EDUNET computer requires the professor to identify himself and (if he has more than one) his account. He types "Mocude, 3XM3X,2"--the "3XM3X" being his pass code and the "2" indicating that this is part of the second of his three network projects.

The computer now asks Professor Mocude to identify the service he requires. He types "CRP" for access to the file of Current Research Projects. If the professor is not familiar with the available services, he can learn about them through multiple-choice or question-and-answer interaction. If he does not know how to interrogate the CRP file, he can request program ASSIST which will interact with him in dialogue, helping him learn (in this instance) how to use the CRP file. Professor Mocude now is able to search through the file of current research projects located 1200 miles from him, almost as though it were on the Erehwyna University campus.

Professor Mocude types a request that the terminal print out a list of all current research on anoxia. After a moment the terminal typewriter replies: "There are 379 projects on anoxia. Unless you want total list, please indicate which of the following categories you are interested in:

"A. Biochemistry of anoxia (128 projects)
"B. Physiology of anoxia (80 projects)
"C. Pathology of anoxia (91 projects)
"D. Anoxia in space medicine (23 projects)
"E. Anoxia in industrial medicine (43 projects)
"F. Miscellaneous (14 projects)."

Professor Mocude types: "C."

The terminal then types back: "There are 91 projects on pathology of anoxia. Unless you want total list, please indicate which of the following categories you are interested in:

"A. Central nervous system effects (31 projects)
"B. Cardiovascular effects (27 projects)
"C. Renal effects (18 projects)
"D. Effects on other internal viscera (8 projects)
"E. Miscellaneous (7 projects)."

Professor Mocude types: "B."

The terminal then types out the list of 27 projects on cardiovascular effects of anoxia, giving also the name of the principal investigator, his address, and his most recent publication concerning that project.

Since Professor Mocude is also chairman of a department, he takes the occasion of being at the terminal to use it to ask an administrative question. The day before his secretary had typed on the terminal Professor Mocude's recommendation for personnel action to appoint Dr. Mocartni as assistant professor in his department. He wishes to know whether this has yet been approved by Dean Tenude. Professor Mocude types EUADMIN (for Erehwyna University Administrative Program).

Then he types PERSONNEL, to indicate that he is dealing with a personnel action. Then he types: "Has Dean Tenude approved Mocartni appointment?" Immediately the terminal types out "Appointment approved 4/28/70."

Professor Mocude types LOG OUT, and the terminal is disconnected from the computer. He destroys the part of the printout which refers to the confidential administrative recommendation relevant to Dr. Mocartni. Since Professor Mocude wants to keep in his personal file the part of the printout which has the list of the projects on cardiovascular reactions to anoxia, he tears off that part and leaves with it.

III. ORGANIZATION

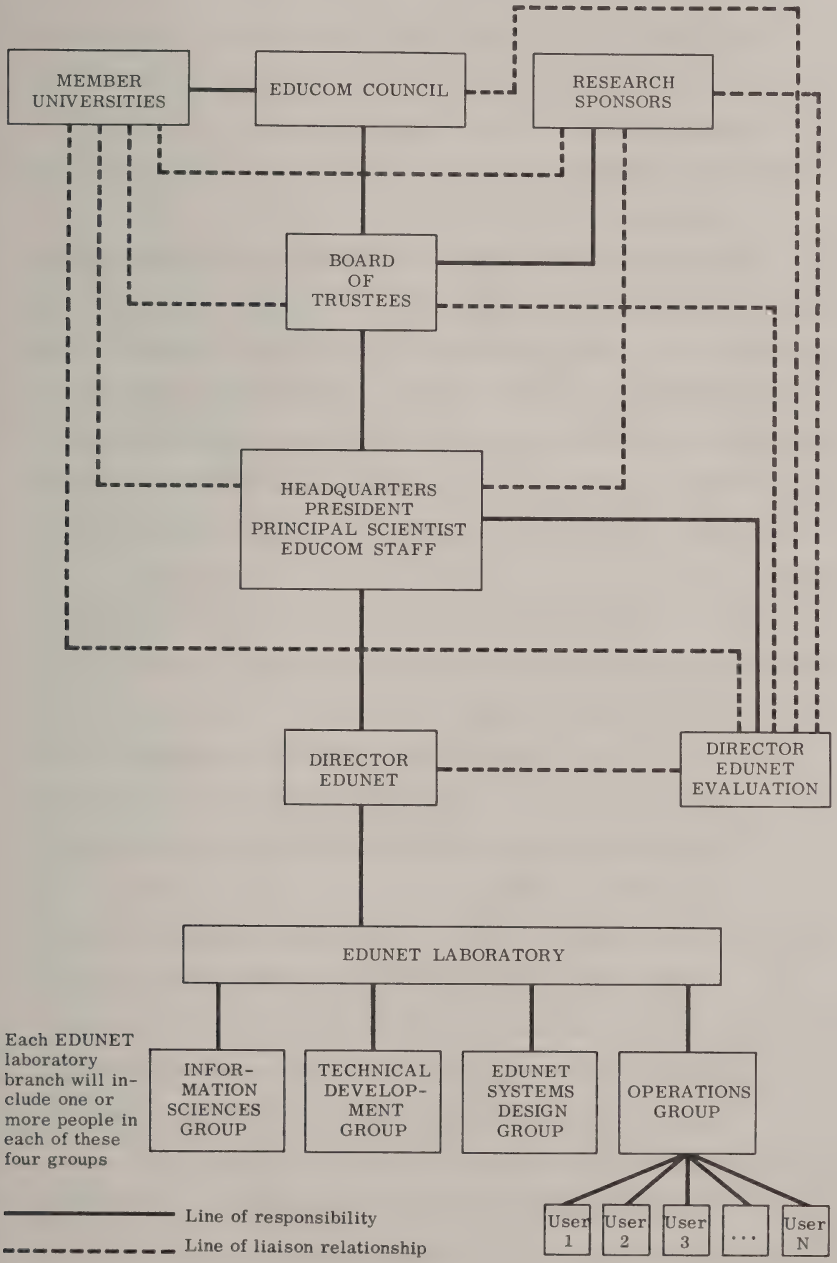
Figure 1 is an organization chart of EDUCOM and EDUNET. Below are job descriptions of EDUNET personnel:

Director, EDUNET

1. Establishes and directs on-going programs in the EDUNET and its laboratory.
2. Translates EDUCOM policy, with respect to the needs and interests of member universities and sponsors, into action programs.
3. Supervises the planning, implementation, and operation of EDUNET.

Director, EDUNET Evaluation

1. Develops and implements methods for determining efficiencies and costs of all aspects of EDUNET operations.
2. Coordinates activities of individual campuses in evaluation of EDUNET services and materials.
3. Obtains evaluations from EDUCOM universities as well as independently, and reports these to the Director of



Each EDUNET laboratory branch will include one or more people in each of these four groups

Figure 7-1. EDUCOM Organization Chart

EDUNET and to EDUCOM headquarters and, when and as appropriate, throughout EDUCOM, to sponsors, and to the public.

4. Intervenes in behalf of users he finds to be discriminated against.

The Director of EDUNET Evaluation will be responsible directly to EDUCOM headquarters so that the evaluation of the network will be independent of its development and operation. He will, however, keep the Director of EDUNET informed of his activities and findings. The Director of EDUNET will be free also to obtain his own day-to-day operational evaluations as necessary for carrying out and improving network operations.

Each EDUNET laboratory branch will have one or more persons in each of the four following groups:

Information Science Groups

1.* Carry out a limited basic research program on specific aspects of interactions between two or more information-processing machines and between men and such machines.

2.* Identify, investigate, and report on potential applications, materials, and services suitable to be made available through EDUNET.

3.* Establish central records of the location, structure, and operation of machine-readable information files and of information networks.

4.* Maintain a national roster of personnel skilled in various aspects of information science and a data bank on information provessing hardware, programs, and content materials.

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*Possible research projects.

5.* Develop educational programs in the information sciences for EDUCOM and EDUNET staffs and EDUNET users.

6.* Provide technical liaison with member university libraries, computer centers, programmed instruction activities, TV and radio centers, and other communication facilities.

7.* Plan and operate an information sciences center that will obtain and dispense facts about such matters as projects in progress, curriculum contents, and substantive activities.

Technical Development Groups

1. Prepare new applications, services, and materials for operational testing on the pilot EDUNET.
2.* Develop input data format standards.
3. Write program specifications.
4.* Investigate multimedia communication loads and costs.
5. Certify technical feasibility and operational readiness of EDUNET and components of it.
6.* Undertake simulations, as required, of alternative possible patterns of EDUNET equipment, content, operations, and use.
7.* Provide appropriate measures for evaluating EDUNET operations, services, and materials.

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*Possible research projects.

EDUNET Systems Design Groups

1.* Investigate and test alternative designs, perhaps with use of simulation methods, for national networks.
2.* Draft detailed specifications for a pilot EDUNET.
3. Direct the construction and installation of EDUNET laboratory branches, switches, nodes, and terminal facilities.
4. Provide the requisite systems programming for EDUNET operations.
5. Provide quantitative and evaluative reports of progress.

Operations Groups

1. Order, install, and operate computer and communications equipment for the EDUNET laboratories.
2. Prepare and operate all EDUNET services, including indexing of them, switching, and accounting.
3. Maintain liaison with all EDUNET users.
4. Maintain technical liaison with communications companies and with companies which manufacture hardware and software. We have received indications that some of these corporations will, at their expense, station personnel at EDUNET laboratory branches who will serve as members of the teams.
5. Deal with the short-range and long-range legal and ethical problems related to network operation (see pages 329-332).

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*Possible research projects.

IV. EDUNET SERVICES

For EDUNET to be most effective it must be organized and planned to serve the specialized needs of a diverse population of users. Some needs are simple, others complex. Some needs demand immediate response of the system whenever it is addressed; others can be as well satisfied by responses delayed hours or days. Some needs are highly personal; others are group needs. Some needs are limited; others are broad. There are needs for, among other things, data and documents. As the term is used here, "data" includes everything from the correct antidote for a poison, which a physician urgently needs to know, to selected tabulations of census statistics desired by a sociologist, to an unusual procedure at a distant clinic observable through a television link by a group of dental students. The word "document" includes everything whose information content can be retrieved locally or remotely.

A. *Sources of Services*

The EDUCOM Summer Study generated a long list of services which could be logically provided by EDUNET. Some of these could be initiated by 1969 or 1970. Others would take a year or more longer to get underway. A partial list of such potential services, most of which will probably be of widespread usefulness, follows. It includes some bibliographical services, which locate needed information, as well as other services which actually retrieve the needed information.

1. Catalogs and directories of bibliographic materials.
2. Abstracts and full texts of documents.
3. Directories of on-going research, theses, proposals, grants, and contracts.

4. Directories of existing data banks and computer programs.
5. Directories of persons with special knowledge and skills.
6. Data banks in various subject-matter fields; *e.g.*, meteorology, drug effectiveness and toxicity, political behavior, city management, land-use, word-use.
7. Diagnostic, therapeutic, epidemiological, and toxicological information (document contents and data banks).
8. Data banks of computer programs.
9. Current awareness services and automatic dissemination services.
10. Collocation of data from geographically dispersed sources.
11. Access to knowledgeable people for "on-line consulting."
12. Computer-assisted instruction.
13. Sharing of experimental facilities.
14. Holding of live classes, seminars, conferences, and professional meetings at dispersed locations.
15. Continuing education.
16. Facilitation of joint authorship and "on-line reviewing."
17. Computer services to remote locations and to computer-poor groups.

More than two dozen sources of machine-readable information which would be of use to EDUNET were identified at the Summer Study. Questionnaires were sent to most of them, and 16 compilable responses were received. All of those responding indicated at least tentative willingness to permit the use of their materials by EDUNET. A list of these agencies is presented on page 34.

Since it may not be possible to make all these services available at once on EDUNET, priorities might be assigned in terms of four criteria: (1) Services having the highest probability of causing significant improvement in specific educational areas. (2) Services offering EDUCOM member universities the greatest range of potential experience in network design, operation, and use. (3) Services most susceptible to evaluation during actual operation, i.e., to the collection of data concerning the aid they provide users. (4) Services available in computer-processible format and useful to EDUCOM universities without expensive modification.

To make each service compatible so it can be used on EDUNET will require different activities. It is hoped that some of this preparation will be done by the agencies providing the information; otherwise, programmers of the EDUNET laboratory will have to do it. For instance, several research libraries jointly might prepare in machine-readable form a union catalog of serial holdings of university libraries, but the EDUNET laboratory staff would have to program it so it could be available on-line on EDUNET. On the other hand, the Library of Congress automation project might be prevailed on to provide their machine-readable catalog of monographs in a form compatible for EDUNET, and the staff of the EDUNET laboratory would simply have to store it and periodically update the store.

B. Media

The pilot EDUNET will explore both analog media (*e.g.*, applications involving voice communication, video communication, telefacsimile) and digital media (*e.g.*, applications involving one- and two-way transmission of alphanumeric data like those stored in computers). It will explore them both separately and in hybrid systems (*e.g.*, digital bibliographic systems coupled to analog systems for transmission of complete documents).

1. *Analog Applications*
   a. *Educational TV*

   Closed-circuit and broadcast TV: Seminars and conferences televised for use at any one university will be made available simultaneously or subsequently to others on the network. TV tapes of lectures, conferences, and group discussions will be provided, on demand, at remote terminals.

   b. *Personal Interchange*

   Among the most fruitful exchanges of information among educators and research people are those that occur at meetings and by telephone. Attending meetings is very costly, and the number of meetings an individual can productively attend is limited. Ordinary telephone communication, of course, is inadequate where visual displays are involved in a discussion. A network capable of supplementing voice communication with graphical communication and perhaps also with an information retrieval service and a computation service would greatly facilitate long-distance personal exchange of information.

   c. *The "On-Line Professor"*

   EDUCOM could arrange for a professor in each specialty area to be available on EDUNET to answer questions posed by students from network terminals, say from 8:00 A.M. to midnight every day. Several professors would rotate. This might help to humanize the "new technology" and enable it to augment human values instead of being an instrument of impersonal automation.

2. *Digital Applications*

a. *Directories*

These are files of metainformation, *i.e.*, information about "who knows what" and "who has what." For example, an on-line version of the National Roster could direct a scientist to colleagues with related special interests working elsewhere in the country. A directory of computer programs could permit one computer center to find out about and to gain access to computer programs prepared and running at another. EDUNET could, of course, transmit the program to the requester or send the requester's data to the center in which the program operates and, after the program had run, return the results. Directory applications are among the simplest to introduce, and they offer immediate benefits to a large number of users.

b. *Bibliographical Materials*

These are files of references to documents, by author, title, content, or location. Maintaining union catalogs in electronic memories and available through the EDUNET would eliminate the current need for libraries to replicate such files and data for local use. Union lists and catalogs get out of date while they are being printed. The ability to attach or detach information from an electronic store, and to provide an essentially current central catalog for remote interrogation, offers the educational community a timely new research tool. Libraries in the United States, including the Library of Congress, are beginning to create bibliographical information in machine-readable form. This trend is certain to lead to a stockpiling of bibliographic data which is capable of computer manipulation and convenient communication to users by digital means.

c. *Facsimile Transmission*

This takes up to six minutes a page with voice-grade telephone lines, but existing systems operate as fast as a page every seven seconds with broader-band lines. Many sorts of written, printed, and graphic materials can be transmitted this way.

C. *Internetwork Communications*

EDUNET will seek interconnection with regional networks (such as those operated by states) and with other national networks (such as those operated by the Federal Government or perhaps private agencies). Other networks or centers fulfilling regional or specialized national roles could interconnect with and use the facilities of EDUNET, providing, of course, that the administrative and necessary financial arrangements were worked out. Examples of other networks and centers for which interconnection with EDUNET would be mutually beneficial are:

1. Communication or computer networks planned by the University of California, MIT, Research Triangle of North Carolina, Dartmouth College, University of Wisconsin, University of Utah, State University of New

York, University of Florida, the Michigan Information System (Michigan State University, Wayne State University, and the University of Michigan). The University of Alabama has in operation a statewide educational television network, and other state and regional television networks are planned.

2. The proposed Educational Communications System of the National Association of Educational Broadcasters and the Eastern Educational Television Network. This includes three networks: An Eastern seaboard "educational resources" network, a network of the Committee on Institutional Cooperation (CIC, *i.e.*, the Big Ten and the University of Chicago), and a network of Oregon state colleges and universities.
3. The various NIH-supported regional medical programs, which may exceed 50 in number.
4. The regional educational laboratories of the Office of Education, which include Newton, Massachusetts; Syracuse, New York; Rougemont, North Carolina; Little Rock, Arkansas; Detroit, Michigan; Austin, Texas; Urbana, Illinois; New York City; Philadelphia, Pennsylvania; Tallahassee, Florida; Charleston, West Virginia; St. Louis, Missouri; St. Paul, Minnesota; Albuquerque, New Mexico; Greeley, Colorado; Kansas City, Kansas; and Washington, D. C. The Educational Research Information Center (ERIC) is also setting up subject-matter oriented research laboratories to be located in Los Angeles, California; Washington, D. C. (2 laboratories); Bloomington, Indiana; Ann Arbor, Michigan; University Park, New Mexico; New York

City (3 laboratories); Columbus, Ohio (2 laboratories); and Eugene, Oregon.

5. Regional MEDLARS search centers established by the National Library of Medicine: those so far announced are at the University of Alabama, the University of Colorado at Denver, UCLA, the University of Michigan, and Harvard University.
6. Eight to ten regional medical libraries (as distinct from MEDLARS centers) provided for in the Medical Library Assistance Act of 1965 and to be established by the National Library of Medicine.

EDUNET may make use of appropriate governmental services which EDUCOM colleges and universities can use, but it would not expect to provide to governmental agencies or to the society at large any services not directly relevant to university functions. EDUNET is restricted chiefly to EDUCOM universities and will not undertake to serve the nation at large. The colleges and universities have a restricted information-processing role in society. Among the services which EDUNET does not currently expect ever to provide are: a law enforcement information network for the FBI and state and local police; a military intelligence network; governmental information services for governmental agencies only; medical information networks for federal or state hospital systems; legal information services to all lawyers; news information networks; information networks purely for profit-making businesses; or networks for transmitting entertainment information to communities.

V. BUDGET

We request support now for at least Phases I, IIA, and IIB, from May 1967 through June 1969. We should also like to have a decision made concerning support for Phases IIIA and IIIB either now or by June 1968 at the latest. Long-term funding is essential if EDUCOM is to give the assurances of stability of the program which will make it possible to attract scientific and professional staff of highest calibre. A chart of the Phase I Plan is shown in Figure 2.

As was explained in the body of the proposal, the necessary budget would be much larger if we did not expect to receive free of charge many machine-readable inputs to EDUNET. As a result of our survey of a number of agencies which are preparing such materials, we believe that this is a realistic expectation, at least for the period covered by Phases I, II, and III.

Another reason why the budget is much smaller than would be necessary to support the total costs of the proposed program is because the following contributions will be made by EDUCOM colleges and universities:

1. Each EDUCOM institution, either from its own funds or from grants for which it makes independent application, will pay for its own connection with the kernel EDUNET, for its own interface with EDUNET, and for as many terminals on its own campus as it may wish to use.
2. Each EDUCOM institution, either from its own funds or from grants for which it makes independent application, will pay the full salaries of all personnel who manage the information system on its own campus.

ACTIVITY	LOCATIONS	FUNCTION	STAFF REQUIRED
EDUCOM Staff	Headquarters Pittsburgh, Pa.	Administer EDUNET, for policy, do legal work, negotiate contracts, carry out liaison and public relations	6
EDUNET Laboratory Branches	Research Triangle, N. C. Ann Arbor, Michigan Southern California A city in the East or Northeast	Serve as nuclei for future operating network Perform information science functions, develop applications, write computer programs, direct standards work Write proposals for research and development projects	30 (Total for 3 or 4 Branches)
EDUNET Switches	Denver, Colo. Chicago, Ill. Pittsburgh, Pa. Boston, Mass.	Provide dial-through exchange service so that terminal users will have direct access to any file in the system at minimum line costs Interconnect with regional networks	Planned in Phase I (Funded in Phases II and III)
EDUNET Terminals and Interfaces	As established by EDUCOM universities and colleges	Provide EDUNET services to users at EDUCOM universities	Planned in Phase I (Equipment and line costs funded by EDUCOM universities and colleges in Phases II and III)

Figure 7-2. Phase I Plan (14 Months—May 1967 through June 1968)

3. Each EDUCOM institution pays the salaries, travel, and expenses of its institutional representatives to attend EDUCOM meetings. It also pays the salaries of members of its faculty who participate in Task Forces. In all except five cases, the salaries of the participants of the 1966 Boulder Summer Study were paid by their own universities.
4. The Research Triangle and the University of Michigan will provide free space and maintenance for the EDUNET laboratory branches located in North Carolina and Michigan.
5. Beginning with Phase IIB, it is expected that each participant institution will begin to pay fees for services which it receives from EDUNET, obtaining the money from funds of that institution or from grants or contracts to the institution. We estimate that the amount of such fees will total approximately $100,000 in Phase IIB, $150,000 in Phase IIIA, and $200,000 in Phase IIIB.

As noted in the proposal, it is possible that various industrial corporations may provide without charge some personnel for the staff of the EDUNET laboratory.

This budget does not suggest the magnitude of support to be required for the research and development activities of the pilot EDUNET beyond June 1970. As the proposal indicates, we cannot at present foresee what will happen after that date. If EDUNET does not succeed, the program will be terminated. If, as is more likely, it shows a degree of success, consideration must, of course, be given as to how it will be operated and supported in future years. It is conceivable that the services will be supplied by one or more industries on a profit-making basis, or by the government. Although in the early years, a government subsidy of some kind may be necessary, ultimately the users of the network, i.e., the universities, should expect to support the network just as today they support their faculties, their libraries, and their physical plants.

Phase I, May 1967 through June 1968 (14 months)

Establishment of EDUNET Laboratory Branches and Detailed Planning of a Narrow-Band Pilot EDUNET

EDUCOM staff (6 persons at an average of $20,000 a year, for 14 months)	$ 140,000
Laboratory personnel (30 persons at an average of $20,000 a year, for 14 months times a factor of 2/3 because of recruitment lag)	466,667
Secretarial and clerical personnel (6 persons at an average of $6,000 a year for 14 months)	42,000
Fringe benefits at 12 percent of salaries	77,840
Communications and travel	25,000
Rental of office and laboratory space for one year (3,000 sq. ft. times $3.00/sq. ft.)	9,000
Equipment and supplies	10,000
	$ 770,507
Overhead or Indirect Costs at 50 percent of salaries	324,334
TOTAL	$1,094,841

Phase IIA, July 1968 through December 1968 (6 months)

Installation and Testing of Narrow-Band Pilot EDUNET

EDUCOM staff (6 persons)	$ 60,000
Laboratory personnel (30 persons)	300,000
Secretarial and clerical (10 persons)	30,000

Phase IIA—Continued

Fringe benefits at 12 percent of salaries	$ 46,800
Communications and travel	25,000
Rental of office and laboratory space (6,000 sq. ft. times $3.00/sq. ft.)	9,000
TELPAK channels (3 months)	480,000*
Equipment and supplies (including rental of four EDUNET switches)	50,000
Computers with direct access files (3 at $33,333 per month, for 3 months)	300,000
Rental and preparation of computer space	180,000
	$1,480,800
Overhead or Indirect Costs at 50 percent of salaries	195,000
TOTAL	$1,675,800

Phase IIB, January 1969 through June 1969 (6 months)

Operation and Extension to all EDUCOM Universities and Participating Organizations of Narrow-Band Pilot EDUNET and Preliminary Planning of Wide-Band EDUNET

EDUCOM staff (8 persons)	$ 80,000
Laboratory personnel (40 persons)	400,000
Secretarial and clerical (14 persons)	42,000
Fringe benefits at 12 percent of salaries	62,640
Communications and travel	25,000
Rental of office and laboratory space (8,000 sq. ft. times $3.00/sq. ft.)	12,000
TELPAK channels	965,000*

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*This amount is higher than suggested in Chapter 6 due to anticipated rate increase for the TELPAK system.

Phase IIB—Continued

Equipment and supplies (including rental of four EDUNET switches)	$ 50,000
Computers and files	600,000
Rental of computer space (9,000 sq. ft. at $2.00/sq. ft.)	9,000
	$2,245,640
Overhead or Indirect Costs at 50 percent of salaries	261,000
SUBTOTAL	$2,506,640
(Less estimated fees from services to universities)	- 100,000
TOTAL	$2,406,640

Phase IIIA, July 1969 through December 1969 (6 months)

Continued Operation of Narrow-Band Pilot EDUNET and Installation and Testing of Wide-Band Pilot EDUNET	SUBTOTAL	$3,250,000
(Less estimated fees from services to universities)		- 150,000
	TOTAL	$3,100,000

Phase IIIB, January 1970 through June 1970 (6 months)

Operation and Extension of Narrow- and Wide-Band Pilot EDUNET to all EDUCOM Universities and Participant Organizations	SUBTOTAL	$3,500,000
(Less estimated fees from services to universities)		- 200,000
	TOTAL	$3,300,000

(Phase III funds are only order of magnitude estimates.)

In addition the EDUNET laboratory and EDUCOM universities may apply for individual contracts and grants for specific projects.

Appendix A

Participants in EDUCOM Summer Study 1966

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Appendix B

Outline of Working Groups

Phase I - Definition of Needs

- I - Clinical Problems (J. H. Friedlander): To consider information needs of medical schools, hospitals, and health practitioners as they relate to the establishment of an EDUCOM interuniversity communications network.
- II - Current Network Configurations (J. C. R. Licklider and Donald R. Quayle): To identify current existing networks in an attempt to show what network configurations might exist which could help to instruct EDUCOM in the establishment of a network.
- III - The Educational Process (Karl Zinn): To state the needs, uses, issues, and problems for educational communications networks in the areas of instruction, research, counseling, administration, continuing education, and public service, giving particular attention to services which would probably not be available without a network.
- IV - Library Needs (Allen Kent): To discuss the need of libraries and information centers; needs to be defined in terms of instruction and learning.
- V - Network Concepts (Milton Terry): To develop the conceptual framework appropriate for practical network configurations within the ESS 66 time frame.
- VI - Current and Prospective Network Applications (Donald Katz): To identify projects or activities from which benefits would be derived by using the network.
- VII - Technical Support (Homer Given): To provide a technical consulting service to all groups.

Phase II - Network Applications

- IV - Library Applications (Allen Kent): As above.
- V - Network Concepts (Milton Terry): As above.
- VII - Technical Support (Julian Kateley): As above.
- VIII - Physical Sciences and Engineering (Mervin Muller): To prepare a list of potential applications suitable for inclusion in a network — in detail and priority order.

IX - Humanities (John R. Shepherd): Same as group VIII.
X - Social Sciences and Professional Schools other than Medicine (George M. Parks): Same as group VIII.
XI - Health Sciences Education and Research (Robert Geertsma): Same as group VIII.
XII - Health Services (Ellis Kelsey): Same as group VIII.
XIII - Organizational and Institutional Context (John P. Witherspoon): To describe the organization and institutional considerations to be taken into account in the development of an EDUCOM network proposal, in preparation for the next phase (i.e., operating responsibilities of EDUCOM vis-a-vis the member universities; accounting; legal implications).
XIV - Preparatory Network Proposal (S. N. Alexander): To outline an EDUCOM network proposal in preparation for following phases.

Phase III - Organizational and Institutional Context

VII - Technical Support (Julian Kateley): As above.
XIV - Network Design "A" (S. N. Alexander): To elaborate on the Phase II preliminary; further to recommend an action program for Phase IV.
XV - Network Design "B" (William Kessler): To develop an alternate network proposal to group XIV's and to recommend a Phase IV action program.
XVI - Network Applications (Don Mittleman): To consolidate viable sets of applications from the Phase II working group effort; to indicate who should undertake to do the initial substantive work; and to relate projected applications to the networks conceived by working groups XIV and XV.
XVII - Network Relationships, Control and Finance (Morris Rubinoff): In view of the proposed applications and proposed network configurations, to determine and examine institutional problems. To develop further the organizational context within which an EDUCOM interuniversity network can function most effectively (e.g., operational responsibilities of EDUCOM vis-a-vis the member universities; accounting; legal responsibilities; relationships to industry and government; intercampus relationships).
XVIII - Relationships with Government, Industry, Professional Societies, and Foundations (Ellis Kelsey): Same as XVII.
XIX - Relationships with Libraries and Computer Centers (Allen Kent): Same as XVII.
XX - Relationships with University Administration (Paul Flint): Same as XVII.
XXI - Relationships with Faculty and Students (Robert Saunders): Same as XVII.
XXII - Relationships with Health Sciences (Donald Wright): Same as XVII.

Phase IV - Preparation of a Specific Network Proposal

XXIV - Communications Configurations (William Kessler):

XXV - Nodal Configurations (S. N. Alexander): To develop open-ended classification of nodes and terminals and their related functions; to identify utility of classes of nodes in relation to short term costs; to suggest a plan for progressive extension of EDUNET (EDUCOM network) capabilities while assuring continuity.
XXVI - Operating Philosophy and Software (William Atchison): To determine EDUCOM responsibilities for software for applications that might use the network, criteria for connection, responsibility for program packages.
XXVII - Information Resource Sharing Applications (Robert Taylor): To determine the scope of an information resource and its applicability and relationship to EDUNET.
XXVIII - Instructional and/or Educational Service Applications (Warren Siebert): To develop specific applications of EDUCOM in the area(s) of instructional or educational service.
XXIX - Health Sciences Applications (Donald Wright): To detail applications of the EDUCOM capability to certain medical science problems.
XXX - Inter-Institutional Problems (Ellis Kelsey): To investigate and make recommendations on criteria that could guide the choice of institutions to be included in the original network, administrative relationships with institutions, extent of EDUNET responsibilities for hardware and software, etc.
XXXI - Finance (E. P. Miles): To consider and make recommendations on the scale and support of an EDUNET staff to develop and evaluate specific network designs.
XXXII - Gaps (Morris Rubinoff): To search for gaps in the assignments that have been made.
XXXIII - Veledictory (Allen Kent).
Proposal Organization (Donald Katz).

Appendix C

EDUCOM Summer Study 1966

WORKING PAPERS

WORKING GROUP	AUTHOR	TITLE	DATE
XXI	Adelson, M.	Evaluation of any Proposed Network	7/19
XXI	Adelson, M.	Toward a Functional Approach	7/19
XXI	Adelson, M.	The Distributed University—Conjectures on What a Network Might Imply	7/19
XXI	Adelson, M.	Working Note #1: Publishers' Rights in Material Distributed Over the Net	7/20
		Working Note #2: Rebates to Network Contributors	7/20
XXVI	Adler, R.K.	EDUCOM's Responsibilities for the EDUCOM Network	7/26
XIV	Alexander, S.	"A" Network Configuration	7/18
XIV	Alexander, S. et al	Network Design "A": Proposal for an EDUCOM Network	7/22
XXI	Atchison, W. F.	Faculty and Student Acceptance of EDUCOM	7/22
XXVI	Atchison, W. F.	Comments on Initial Stages	7/28
X	Balintfy, J. L.	On the Application of Computer-Assisted Menu Planning (CAMP) in the EDUCOM Network	7/18
II	Beck, J.	Examples of Computer Networks	7/15
XXV	Booth, R. and Kromp, C.	Classification of Suggested EDUCOM Applications Based on Report by Group XVI dated July 22	7/27
XXV	Booth, R. & Kromp, C.	Guidelines for Priority I of Applications Classified for Implementation During 1967	7/27
XI	Bartscht, K.	University Internal vs University External	7/15

WORKING GROUP	AUTHOR	TITLE	DATE
XVII	Caffrey, J.	Operating Philosophy and Software: Some Reflections	7/25
	Caffrey, J.	Notes on Operating Philosophy	7/28
XXVI	Caffrey, J.	The Total System	7/26
XXVII	Campbell, S.	Resource Sharing of Documentary Information Systems Capabilities	7/28
XIV	Carr, J. W.	A Proposed Functional Description of an EDUCOM System	7/20
XI	Conrath, C. et al	Community Health Care Systems	7/13
XVIII	Davies, P.M.	Relationships of EDUCOM to the Non-University Community	7/24
III	Denum, D.	Role of the Professor as Instructor	7/8
III	Denum, D.	Review of Instructional Materials in a Network, with Academic Recognition for Outstanding Work	7/11
XXVIII	Diekhoff, J.	Network-Assisted Means of Accessing Other Campuses Without Remoting Oneself	7/27
XXI	Drew, D.	Issues and Problems of EDUCOM Related to Individual Faculty Members and Students	7/22
XXVI	Drew, D.	Operating Characteristics of an EDUCOM System	7/27
XXVI	Drew, D.	Comments on Software Start Up	7/28
III	Flint, P.	Protection of the Originator of Instructional Material	7/11
XX	Flint, P.	Role of University Administrators in EDUCOM	7/22
II	Foster, W. & Hersey, D.	National Library and Information Centers Current Networks or Systems	7/11
XXX	Friedrich, L. W.	Administrative Relationship of EDUCOM with Institutions in the Network	7/28
VI	Geertsma, R.	Interinstitutional Collaborative Investigation	7/11
XI	Geertsma, R.	Annotation Bibliography of Learning Aids in the Health Sciences	7/14
XI	Geertsma, R.	Student Admissions Procedures	7/18
XI	Geertsma, R.	Applications	7/18
XVI	Gerard, R. W.	Report to EDUCOM Central from Task Force on Educational Systems and Technology	7/17

WORKING GROUP	AUTHOR	TITLE	DATE
VI	Glazer, E.	Strategic Questions in the Selection of Some Illustrative Applications	7/6
XVIII	Grabbe, E.M.	Advantages of an Open System for EDUCOM Services	7/19
XXIV	Grabbe, E.M.	Comparison of Network Design "A" and "B"	7/22
XIV	Grosvenor, D. & Katz, D.	On-line Debugging and Computation Service	7/25
XXXI	Haas, W.J. & McMains, H.J.	Pricing Considerations for an Operating EDUNET	7/27
XXVII	Hanson, J.W.	Computer Resources Sharing Applications	7/27
VI	Hanson, J.W.	Immediate Voice Communications Network	7/11
II	Hanson, J.W.	Background and Progress Report on the Triangle Computation Center and the North Carolina Computer Orientation Project	7/27
VII	Hayes, R.	Bibliography Relevant to National Information Networks	7/15
XVII	Hayes, R.	Network Relationships—Control and Finance, p. 14-20	7/21
VII	Hubley, R.E.	EDUCOM Facility	7/19
VI	Hubley, R.E.	EDUCOM and Western Union	7/20
V	Hubley, R.E.	Classification of Some Principal Source Information Input/Output Devices and the Common Carrier Network(s) They Commonly Utilize	7/14
II	Jensen, J.R.	Addendum to Television Networks (Quayle): ETV Network Configurations	7/25
XXXI	Jensen, J.R.	Summary of Replies from Selected Universities and Colleges Concerning Television Practices	7/26
XXX	Jones, J.V.	The Desired Relationships with Institutional Groupings of Academic Units	7/28
VI	Katz, D.	Network Seminars in Advanced Engineering Topics	7/9
VI	Katz, D.	Addendum to Table I of July 7 Summary: Allocation of Resources	7/11

WORKING GROUP	AUTHOR	TITLE	DATE
XIV	Katz, D.	Interpretation of Seismic Data	7/19
XIV	Katz, D.	Information File Seminar	7/19
XIV	Katz, D.	Remote Interviews of Leading Personalities by Journalism Classes	7/20
XXIV	Katz, D.	Interchange in Use of Computer Programs	7/24
XIV	Katz, D. & Kateley, J. et al	Preliminary Estimates of Communications Costs	7/25
XIV	Katz, D.	Applications of Communication Network by Function	7/28
	Katz, D.	EDUNET Committees	7/28
XXVI	Katz, D.	Precautions to Avoid Overload and Failure of Communication Systems	7/28
X	Kearns, J.A.	Network Applications and CAI	7/14
XII	Kelsey, F.E.	The Application of Modern Information Technology	7/13
XXX	Kelsey, F.E.	EDUCOM Organization and Function	7/28
XXXIII	Kent, A. et al	Reflections on Summer Study on an EDUCOM Information Network (Valedictory)	7/29
XV	Kessler, W.J.	"B" Network Configuration	7/21
XV	Kessler, W.J.	Principal Features of Design Alternative B	7/22
XV	Kessler, W.J.	Alternate Network Design B	7/22
VII	Kessler, W.J.	Glossary of Terms	7/11
XXIV	Kessler, W.J.	EDUCOM Interregional Network Proposal	7/27
V	Kochen, M.	What are Central Functions of EDUCOM	7/14
V	Kochen, M.	Creation of Centralized Files	7/18
II	Licklider, J.C.R.	Interim Report: Current Network Configurations	7/8
II	Licklider, J.C.R.	Response to James G. Miller's "Questions to be Considered and Answered during the 1966 EDUCOM Summer Study on Educational Communications Networks"	7/8
II	Licklider, J.C.R.	Two Approaches to the Problem of Interuniversity Networks	7/8
II	Licklider, J.C.R.	Concepts and Symbols Pertinent to the Planning of Information Networks	7/9

WORKING GROUP	AUTHOR	TITLE	DATE
IX	Licklider, J.C.R.	On the Little Man in the Machine	7/14
XXVI	Lowe, T. C.	Terminal Device Software Responsibility	7/27
XXVI	McCormick, J.	Comments on Timing	7/28
XXVI	McCormick, J.	EDUCOM Operating Philosophy with Respect to Membership	7/27
VI	McCormick, J.	Problems in Data Handling	7/20
XVII	Mehlman, S.J.	Network Relationships—Control and Finance, p. 26-28	7/22
XXIV	Mehlman, S.J.	Channel Requirements—Gross, Rough Estimate	7/28
XXIV	Mehlman, S.J.	Analog/Digital Transmission	7/29
XXIV	Mehlman, S.J.	EDUCOM's Role in Achieving State-of-the-art Performance in Transmission Facilities	7/29
XXIV	Mehlman, S.J.	Long Distance, Wide-band Transmission	7/29
VI	Merrifield, P.R.	Characteristics of Applications	7/8
VI	Merrifield, P.R.	Coordinating Applications of EDUCOM Capabilities	7/11
III	Merrifield, P. and Mood, A.	Information Needs of University-based Researchers	7/11
III	Merrifield, P.R.	Researchable Problems on Research Use of Networks	7/11
III	Merrifield, P.R.	Training EDUCOM Users	7/12
XXI	Merrifield, P.R.	EDUCOM - induced changes within the university	7/26
XXVII	Mersel, J.	Education Research Information Center ERIC	7/26
IV	Mersel, J.	A List of Items to be Considered in the Automation Through a Network of the Libraries in the EDUCOM Community	7/14
IV	Mersel, J.	The Nature of the Files for Purposes of the Library	7/15
VIII	Miles, E.P.	Mathematics Needs and the EDUCOM Network	7/14
VIII	Miles, E.P.	Network Aids to Public Information Service Activities of Universities	7/20

WORKING GROUP	AUTHOR	TITLE	DATE
XX	Miles, E.P.	An Intracom Case History with Implications for the EDUCOM Network	7/25
XXXI	Miles, E.P. et al	Final Report: Finance	7/28
XXVIII	Miles, J.	Sharing of Human and Physical Resources Among Multiple Institutions	7/27
XXIV	Miles, J.	Current Educational Communications Systems and the Need for Integration and Standards	7/27
XXX	Miller, J.G.	Compilation of Replies to Questionnaire Sent to EDUCOM Universities	7/26
XXVII	Miller, J.G.	Statistical Summary of Responses Compiled from Questionnaires from Agencies Known to be Possible Sources of Machine-Readable Information	7/28
X	Miller, R.	Applications for the Social Sciences of EDUCOM Television Network	7/18
XXX	Miller, R.	The Role of EDUCOM in Leadership and Control of Future Network Developments	7/28
XXX	Miller, R.	Criteria in Choice in Institutions for a Network	7/28
XVI	Mittleman, D. et al	Network Applications Working Paper	7/21
XVI	Mittleman, D.	Network Applications	7/25
IV	Mittleman, D. & Parks, G.	Additional Hardware/Software Requirements	7/11
III	Mood, A.	Evaluation of an Interuniversity Network	7/18
VII	Norback, J.O.	Glossary of Terms (Second Edition)	7/23
XXIV	Norback, J.O.	EDUCOM and the Common Carriers	7/28
XVII	Oettinger, A.	Network Relationships—Control and Finance, p. 25	7/22
XXVII	Oliveri, B.L.	Available and Planned National Agricultural Library Resources	7/26
XXVII	Oliveri, B.L.	Location Systems for On-going Research and Published Resources	7/28
XXIII	Paddock, R.	EDUNET-EDUCOM Relations	7/25

WORKING GROUP	AUTHOR	TITLE	DATE
XVII	Penney, M.	EDUCOM Can Help	7/25
XXVII	Pierce, W.	Subsidiary Networks	7/27
XI	Ramage, W.	Computer-Aided Learning	7/14
XXVIII	Ramage, W.W.	Professional Society Remoting to Participating Campuses	7/27
XXX	Rikli, A.E.	Recommendations on Relation of EDUNET with Other EDUCOM Members such as Other Colleges, Professional Societies, Government and Industrial Laboratories. Is There any Need for Distinction	7/28
XXVII	Rogers, F.B.	Library-type Resources: Reference Searching Systems (Consideration of Some Alternate Information Stores)	7/27
XVII	Rubinoff, M.	Network Relationships—Control and Finance, p. 29-33	7/22
XVII	Rubinoff, M.	Group Revision of Working Paper #4, p. 8-9 by E. Stefferud, July 21 (p. 35-36)	7/23
XVII	Rubinoff, M.	Network Relationships—Control and Finance: Some Premises and Assumptions	7/23
IX	Sawin, L.	Computer Applications in Research in the Humanities in Relation to the EDUCOM Network	7/12
XVII	Schwartz, J.	Network Relationships—Control and Finance, p. 10-13	7/22
VI	Selfridge, O.	The Network Interchange of Computer Programs	7/11
IX	Selfridge, O.	Real People and Real Problems	7/14
XII	Shellow, J. & Wright, D.	Poison Information Control, Part II	7/14
XVII	Shellow, J.	Network Relationships—Control and Finance, p. 1-2	7/18
XVII	Shellow, J.	Network Relationships—Control and Finance, p. 5-7	7/20
VI	Shepherd, J.R.	Current and Prospective Applications of the Proposed Network	7/11
IX	Shepherd, J.R. et al	The Promise of EDUCOM for the Humanities	7/14
XXIII	Shepherd, J.R.	EDUNET and the Local Representative	7/22
XIV	Seibert, W.F.	Operational Considerations: A Draft	7/20

WORKING GROUP	AUTHOR	TITLE	DATE
XIV	Seibert, W.F.	Participation in Network Experimentation: A Draft	7/20
XXVIII	Seibert, W.F.	Instructional Applications	7/26
XXVIII	Seibert, W.F.	Application of the Network to the Conduct of "Junior" Professional Society Meetings	7/27
XVII	Stefferud, E.	Network Relationships—Control and Finance, p. 3-4	7/20
XVII	Stefferud, E.	Network Relationships—Control and Finance, p. 8-9	7/21
XVII	Stefferud, E.	Network Relationships—Control and Finance, p. 24-25	7/22
XVII	Stefferud, E.	The Environment of Scheduling	7/25
XXX	Stewart, I.E.	Identification of Functions on Which EDUNET (EDUCOM) Should be Ready to Negotiate with Network Members (Potential or Actual)	7/28
V	Taulbee, O.	Standards	7/13
XVII	Taulbee, O.	Network Relationships—Control and Finance, p. 21-23	7/21
XXVII	Taylor, R.S.	Information Resource Sharing Applications	7/27
XXVII	Taylor, R.S.	Data Resources	7/29
II	Wallace, R.	Conference Communications Systems	7/8
XIII	Witherspoon, J.	Report of Discussion Group XIII: Organizational and Institutional Context	7/15
XXIII	Woodbury, M.	EDUNET Organization	7/19
XXIII	Woodbury, M. et al	EDUCOM-EDUNET Relations	7/20
XXIII	Woodbury, M. and Cheshier, R.	A Library is an Information Source, Not a Repository for Books	7/22
XXIII	Woodbury, M.	EDUNET R & D Effort	7/25
XXIII	Woodbury, M.	EDUCOM Relationships	7/26
XII	Wright, D.	A Proposal for a Toxicological Information Network	7/13
XXIX	Wright, D. et al	Medical Sciences—Final Report	7/28

WORKING GROUP	AUTHOR	TITLE	DATE
III	Zinn, K.L.	The Importance of Relevant, Available, and Interpretable Data in an Individualized Mass Instruction System	7/11
III	Zinn, K.L.	FIT, A Translator for Instruction Oriented Interactions	7/13
III	Zinn, K.L.	Organization of Network Services	7/15
III	Zinn, K.L.	Summaries of Working Papers, 7/6-7/18	7/19
III	Zinn, K.L.	Network Benefits for Instruction	7/23
VII	Zinn, K.L.	Terminology: Computers in Education	7/18
XVII	Zinn, K.L.	Criteria for Assessing Appropriateness of Specific Network Applications	7/21
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Appendix E

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Appendix H

Glossary of Terms

INTRODUCTORY NOTE

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A "Glossary of Terms" has been released earlier as a simplified, nonrigorous glossary of the more common terms used in network technology. This second generation version is essentially a "second edition" in which some additional terms have been added and the definitions made more rigorous for the benefit of the communications engineer as well as nonengineering groups.

Thus, this "Second Edition" is in closer agreement with definitions adopted by the "Standards" organizations such as the Communication Common Carriers in the U.S., American Telephone and Telegraph (AT & T), General Telephone and Electronics (GT & E), the various independent telephone companies and the Western Union Telegraph Company (W.U.) as well as from the standpoint of the International Organizations such as CCITT, CCIR, etc. Terminology is heading towards international standardization primarily due to the efforts of the above organizations in addition to the efforts of the Institute of Electrical and Electronics Engineers (IEEE), American Standards Association (ASA) and the Electronic Industries Association (EIA).

Rather than spend a great deal of time in developing a new glossary of terms, it appears more desirable to take advantage of the work done over the past several years by the above organizations. Interested persons are particularly referred to the "Glossary of Terms" as published by the American Standards Association, the Electronic Industries Association and the Institute of Electrical and Electronics Engineers (all headquartered in New York City), the "Communications Dictionary" by James F. Holmes and the "Data Transmission and Data Processing Dictionary" by James F. Holmes, both available from John F. Rider Publishing Company Inc. in New York.

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However, since the referenced "Working Paper" was distributed at this session it appears desirable to prepare another and augment the original, but by no means complete, glossary of terms for comparison purposes. The format and numbering system of the aforementioned working paper have been followed in this revision. New terms are denoted by a number taken from the original working paper followed by a letter suffix; that is, 1(a), 1(b), etc.

GLOSSARY OF TERMS
(Communications Networks)

1. FULL DUPLEX CIRCUIT: a full duplex circuit is a two-way communications channel making it possible to send and receive simultaneously at or near the same speed of transmission. A slow speed reverse channel feature used on some data transmission systems is not considered to be a full duplex circuit. An ordinary telephone circuit may be considered full duplex.

1(a). HALF DUPLEX: a half duplex circuit is a communications two-way channel arranged so that only one-way transmission can take place at any given time. TWX Service may be considered as half duplex.

2. SINGLE SIDEBAND SUPPRESSED CARRIER (SSBSC): SSBSC is a method of modulation of a carrier signal in which only one sideband is transmitted, either upper or lower, to conserve the frequency spectrum space on a carrier system and to allow more efficient utilization of the baseband of a radio/microwave system. Since the carrier under this condition carries no information, it is suppressed under conditions of no modulation. Under conditions of modulation either the upper or lower sideband is also suppressed since when referenced to the other it contains redundant information. SSBSC carrier equipment is complex and expensive and finds primary applications in high density cable carrier systems and particularly in radio/microwave systems.

2(a). DOUBLE SIDEBAND SUPPRESSED CARRIER (DSBSC): DSBSC is a method of modulation of a carrier signal in which both sidebands generated by the modulating information are

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transmitted. The carrier signal under condition of no modulation is suppressed. This is not a popular form of modulation primarily due to the complexity of the demodulator.

3. DOUBLE SIDEBAND-AMPLITUDE MODULATION (DSB): DSB amplitude modulation is the common or familiar method of modulation in which the carrier and both sidebands generated by the modulation process are transmitted, as an "AM" Broadcast Station. DSB Carrier systems find primary applications on short travel (under about 200 miles) cable carrier systems. Modulators and demodulators are simple and inexpensive. They should not, however, be used as multiplex equipment on radio/microwave systems since they are wasteful of the frequency spectrum.

3(a) VESTIGIAL SIDEBAND (VSB): VSB is a method of modulation of a carrier signal in which either the upper or lower sideband is suppressed. On a VSB system the carrier is only partially suppressed. VSB equipment is not as complex as SSBSC equipment but it is more complex than DSB equipment. In recent times primary applications are for wideband-high speed data transmission (analog or digital).

4. FREQUENCY DIVISION MULTIPLEX (FDM): the technique of deriving communication channels where each individual channel is assigned to a specific but different part of the frequency spectrum.

5. TIME DIVISION MULTIPLEX (TDM): the technique of deriving communication channels where each individual channel is assigned to a specific but different time slot. This is essentially a time-sharing system in which the sampling rate is sufficiently high so that no loss of message continuity is detectable by the user.

NOTE: With reference to terms 4 and 5 above, in a frequency multiplex system a specific but different frequency segment is assigned to each channel on a fulltime basis whereas in a time division multiplex system the entire wide band frequency bandwidth is assigned to each channel on a rapidly cycling time-shared basis. Time division multiplex systems require several times the bandwidth of a frequency division

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system to transmit the same information since a time division multiplex must be sampled at least eight times as fast as the highest desired modulating frequency.

6. MULTIPLEX (MUX): a technique of deriving multiple communication channels from a wide band channel where each such communication channel is of lesser band width than the wide band channel. These communication channels may be derived either by FDM or TDM techniques (see terms 4 and 5 above).

7. INTERFACE: a defined electrical and mechanical junction between electrical circuits and/or systems. In a data transmission system there are at least two interface points; i.e., the interface between a data set (modulator and/or demodulator) and the communications channel. Control and circuit assurance features are normally associated with the interface between the data set and the related computer equipment on well engineered systems.

7(a). DATA SET: a data set is modulator and/or demodulator which converts the electrical signals from the associated computer equipment into signals which may be transmitted over a communication channel and vice versa at the receiving end.

8. HETERODYNE REPEATER: a microwave repeater which amplifies the incoming signal and offsets the frequency of the input signal without involving the processes of demodulation and modulation. Modulation and demodulation processes invariably degrade the information signal handled and thus serve no useful purpose in a relay or repeater microwave system unless the specific system requires the drop-off of communication channels at relay or repeater points. Heterodyne repeaters are sometimes referred to as IF repeaters (Intermediate Frequency repeaters). They are expensive and complex and find primary applications in high density medium and long travel systems (over about 200 miles).

9. REMODULATION REPEATER: a microwave repeater made up of terminal type microwave receivers and transmitters connected back-to-back to form a relay unit. Remodulation repeaters of

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this type are cheaper than heterodyne repeaters but they invariably introduce degradation of the signal. Remodulation repeaters are sometimes referred to as baseband repeaters. They find primary applications in short travel (under about 200 miles) and light density systems and also in conjunction with a heterodyne repeatered system at such repeater points where it is necessary to drop-off communication channels.

10. BANDWIDTH: (a) The numerical difference between highest frequency and lowest frequency handled by a communication channel, terminal device or transmission point(s). The bandwidth of a channel is normally expressed in terms of the available useable frequencies between either the three-db. or six-db. points on the low and high frequency ends of the channel; for example, ±1 db. between 300 Hz and 8 MHz, ±0.25 db. between 300 Hz and 2800 Hz, etc. (b) Bandwidth may also be defined as the frequency spectrum required by a specific modulating rate and method when applied to a communication channel and similarly, the frequency bandwidth occupied by a microwave transmitter as defined by the Federal Communications Commission (See Part II of the FCC Rules and Regulations).

11. NARROW BAND: this is a relative term but is usually meant to be a communication channel of less than voice-grade; i.e., a telegraph, teletypewriter, or low speed data channel.

12. MEDIUM BAND: a meaningless term to be avoided (see below).

12(a). VOICE BAND: this is also a relative term but is usually meant to be either a communication channel extending from about 300 Hz to 3000 Hz for Communications Common Carrier switched message telephone service or from about 300 Hz to 3200 Hz for Communications Common Carrier private line telephone and/or alternate voice/data services.

NOTE: a voice band or voice-grade channel has been referred to by some as a "medium band" channel. This term is meaningless and should be avoided.

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13. BROADBAND: sometimes referred to as wide band. A bandwidth greater than a voice-grade channel. The upper limit is not specifically defined except on certain service offerings such as, Program Channels, 5000 Series Channels (i.e., Telpak Channels), Video (TV) Channels, etc.

14. CYCLES PER SECOND (CPS): a term recently relabelled as HERTZ (Hz) to conform with International Agreements. Similarly, this also applies to KC, MC, KMC, GMC, etc. (See below.)

14(a). HERTZ (Hz): a relabelled term for cycles per second (CPS) to conform with International Agreements:

Old Method		New Method
1 CPS	=	1 Hz (Hertz)
1 KC	=	1 KHz (Kilo Hertz)
1 MC	=	1 MHz (Mega Hertz)
1 GC	=	1 GHz (Giga Hertz)

15. BIT: a contraction for a BInary digiT. In digital data transmission: (a) the minimum amount of information necessary to distinguish between two equally likely alternatives, such as "0" or "1" where "0" is a bit and "1" is also a bit.
(b) the signalling speed per second expressed as bits per second or B/S.

15(a). DIGIT: a single symbol representing an integral quantity.

15(b). MARK: a contact made, for example when a telegraph key is depressed for the "1" bit.

15(c). SPACE: in telegraphy for example, the signal condition opposite to mark or the "0" bit.

15(d). CHARACTER: (a) Five-level Permutation Code (Baudot Code)—a start pulse followed by 5 information bits all the same length followed by a 40% longer stop pulse.
(b) American Standard Code for Information Interchange (ASCII)—a start pulse followed by 8 information bits plus two stop pulses all unity based. This is an 8-level code.

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15(e). WORD: (a) in data transmission: six characters (five characters plus a space)
(b) computing: a fixed capacity of character storage whose length is determined by equipment (machine) design.

15(f). BYTE: a group of bits (usually 8) manipulated as a unit in data processing equipment.

16. INFORMATION: in data transmission, a term generally meaning the intelligence portion of the desired transmission.

16(a). INFORMATION BITS: in data transmission those bits which identify the character, symbol, or control function after the start-stop-sync and parity bits have been removed.

NOTE: All bits, i.e., start-stop-sync and parity must be taken into consideration when transmitted on a communication channel.

16(b). INFORMATION CAPACITY OF AN IDEAL CHANNEL: from the standpoint of the Information Theory as defined by Shannon:

$$C = W \log_2 (1 + S/N)$$

where:

C = channel capacity in bits per second
W = channel bandwidth in Hertz (Hz)
S/N = signal to random noise power ratio.

NOTE: Strictly speaking, this equation provides a measure of the maximum information capacity of a communication channel which is not always achieved in practice. From a practical standpoint a good figure to use is two bits per cycle of bandwidth. Watch the state-of-the-art, however.

17. NOISE: there are several types of noise and many ways of measuring them. Generally speaking, noise may be considered as random extraneous electrical variations present in the communication channel and terminal equipment caused by random thermal motion of electrons which tend to obscure the identity of the desired signal and or digital data bit stream.

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17(a). IMPULSIVE NOISE: often referred to in the U.S. as Impulse Noise: Impulsive Noise is caused by power and/or switching transients. Lightning storms also cause impulsive noise. Impulsive noise need not be random in nature and may reach levels several times as high as the desired signal and/or digital data bit stream.

18. MODEM: a generic term meaning modulator and demodulator combined in a data set or terminal device.

19. MODULATION (MOD): the process of varying any one of the characteristics of a carrier signal in accordance with the intelligence to be transmitted over a communication channel.

20. DEMODULATION (DEMOD): the inverse of modulation or the process of recovering the original signal intelligence at the destination end(s) of a communications system.

21. FREQUENCY MODULATION (FM): the modulation process of varying the instantaneous frequency of a carrier signal in accordance with the information transmitted.

21(a). PHASE MODULATION (PM): the modulation process of varying the instantaneous phase of a carrier signal in accordance with the information transmitted. In end effect, this is similar to FM.

22. AMPLITUDE MODULATION (AM): the modulation process of varying the amplitude of a carrier signal in accordance with the information transmitted.

22(a). TIME DIVISION MODULATION SYSTEMS: there are several types of time division systems; (e.g.) Pulse Code Modulation (PCM), Pulse Position Modulation (PPM), Pulse Amplitude Modulation (PAM), Pulse Duration Modulation (PDM), etc. The one in common use today is the PCM system. See term 5 for a partial definition.

23. BAUD: a term derived from the Frenchman Jules Baudot who developed the Baudot Code. This is a term often confused with bits. A baud may be defined as the unit of signalling speed equal to

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one signal element per second. In practical usage one would say, "I am signalling at a rate of 150 bauds," as compared to a person who is transmitting 150 B/S. In modern usage however, and when considering unity based code systems, B/S and bauds may be used interchangably. In other words, B/S are not equal to bauds when using the permutation code (Baudot Code) but B/S equals bauds when using ASCII.

24. VOICE-GRADE CIRCUIT: see definition on term 12(a).

25. MICROWAVE: microwave systems are used to transmit data, multi-channel telephone and telegraph, or television (video) signals from point-to-point utilizing the frequency range from about 800 MHz to about 13 GHz.

NOTE: Radio/microwave systems fall under the jurisdiction of the Federal Communications Commission (FCC).

26. SLOW-SCAN TV: A slow-rate television system in which the picture scan rate is reduced from about 30 frames per second (home type conventional TV) to about one frame per minute (a series of "stills" actually) so that the bandwidth requirements can be reduced to about 2700 HZ, ordinary voice band telephone circuits may be used for transmission purposes. Slow-scan TV may be regarded as a facsimile type system (analog) using video origination (TV) and display equipment with modified (reduced) rate—lower resolution scanning standards.

27. CARRIER: Often referred to as "carrier signal." Any continuous electrical signal whose frequency, phase, or amplitude may be varied under the influence of the intelligence being transmitted.

27(a). CARRIER SYSTEM: A multi-channel system utilizing multiplex techniques.

28. SUBCARRIER: A secondary continuous electrical signal, lower in frequency than the main carrier, that is normally used as a pilot (5) or regulating carrier for stability and/or synchronization purposes.

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29, CCITT: The International Telephone and Telegraph Consultative Committee which establishes international standards for telephone, telegraph, data, and signalling systems.

30. CCIR: The International Radio Consultative Committee which establishes international standards for radio/microwave systems.

31. ITU: The International Telecommunication Union with offices in Geneva, Switzerland, which is a subdivision of the United Nations and the parent body of the CCITT and CCIR Committees.

32. BASEBAND: The useful bandwidth of a communication system which begins in the voice frequency range or below and extends upwards to as high as 8 to 19 MHz.

33. RADIO FREQUENCIES (RF): the range of frequencies assigned to the carrier of a communication system which is always many times higher in frequency than the Baseband frequencies.

34. ANALOG DATA: Literally, resembling something else.
(a) In communications systems: an information signal whose magnitude is always directly proportional to the intelligence it represents.
(b) In computers: The principle of performing calculations with voltages and currents whose magnitudes are directly proportional to the magnitude of the physical quantities they represent.

NOTE: Speech has been considered to be analog data when transmitted over a communication channel. In the past this was in most instances true. However, with the introduction of PCM techniques speech may also be digital in nature in-so-far as the communication channel is concerned.

35. DIGITAL DATA: (a) A quantity of information which is composed of symbols or characters of information.
(b) Information expressed in discrete numerical values or amplitude levels based on any convenient numbering system. For example: In Decimal systems 10 discrete numbers or levels. In Binary systems 2 discrete numbers or levels such as 0 or 1.

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36. TELPAK: A contraction for telephone package (TELPAK) which provides communications facilities to be used for broadband channels or channels of lesser grade, combinations of the two, or broadband channels and channels of lesser grade on an alternate basis.

36(a). 5000 SERIES CHANNELS: Broad Channels (TELPAK) as defined in AT&T Co. FCC Private Line Tariff 260.

NOTE: There are two types of channel arrangements available, i.e., voice channels and alternate voice/data channels which include data only channels. Listed below are the two types and for comparison both the old and new terminology have been shown:

VOICE CHANNELS

Old System	Equivalent Voice Channels	Approximate Bandwidth	New System
TELPAK A	12	48 KHZ	5500
TELPAK B	24	96 KHZ	5600
TELPAK C	60	240 KHZ	5700
TELPAK D	240	1 MHZ (approximately)	5800

ALTERNATE VOICE/DATA CHANNELS
or
DATA ONLY CHANNELS
5000 Series Channels

Old System Channel Terminals	Equivalent Voice Channels	Approximate Bandwidth	New System Channel Terminals
TELPAK A1	12	0-20,000 HZ.	5502
TELPAK A2	12	40.8 K B/S plus 1 voice freq. chan. for coordination.	5502
TELPAK A3	6	29-44 KHZ plus 1 voice freq. chan. for coordination.	5503
TELPAK A4	12	Max. 50 KB/S plus 1 voice freq. chan. or control chan.	5504

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Old System Channel Terminals	Equivalent Voice Channels	Approximate Bandwidth	New System Channel Terminals
TELPAK A4 (continued)	12	or on an alternate basis (Sync. or non-sync. data).	5504
TELPAK A5	6	19.2 KB/S plus 1 voice freq. chan.	5505
TELPAK C1	60	0-100,000 HZ	5701
TELPAK C2	60	105 KB/S plus control channel and 1 voice freq. chan.	5702
TELPAK C3	—	Deleted	
TELPAK C4	60	U.S. Govt. only	5704
TELPAK D1	228	500 KB/S plus Error checking and control channel.	5801

37. LONG DISTANCE XEROGRAPHY (LDX): LDX is a facsimile transmission system utilizing the Xerox electrostatic process for reproducing hard copies at the receiving end.

38. AUTOMATIC VOICE NETWORK (AUTOVON): AUTOVON is a world wide voice communication network operated for the U.S. Department of Defense (Overseas AUTOVON and CONUS-AUTOVON).

39. AUTOMATIC DATA NETWORK (AUTODIN): AUTODIN is a world wide digital data transmission or communication network operated for the U.S. Department of Defense.

40. COAXIAL CABLE: A cable consisting of an outer cylindrical sheath about 1/4 inch to 3 inches in diameter, and a center conductor held in place by insulating material. A coaxial cable exhibits fairly uniform transmission properties over a very wide range of frequencies and is thus a good wideband transmission medium. Presently available coaxial cable of good design is usable over the frequency range of about 4 MHZ to 220 MHZ. On the lower frequency end of the band (below about 100 HZ to 500 HZ) the impedence properties of the coaxial cable change and therefore it may become unusable except for very short runs. Baseband video and voice frequencies should not be applied to coaxial cable

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except on very short runs (about 25 to 200 feet maximum). Note: When considering coaxial cable as a transmission medium one of the major advantages is that the repeaters are located fairly close to one another, say in the order of about 4000 to 6000 feet. This coupled with the fact that some of them are regenerative in nature provides a very high quality transmission medium.

40(a). VIDEO PAIRED CABLE: This is a shielded balanced cable system which exhibits fairly uniform transmission characteristics from about DC to 10 MHZ. Frequencies much higher than about 10 MHZ should not be applied to video paired cable because the cable begins to radiate the transmitted signal. This is a short haul transmission system when used to provide video services.

NOTE: The following new term is also added since there appears to be some misunderstanding of its use:

41. NODE: Webster defines "node" as a knot. In this sense one could conclude that a "node" is a "tie-point" or a "point of interconnection." Therefore the following two definitions are proposed:

(a) On a specific network a node is: a point for accommodation of terminal equipment to connect it to the communications system.

(b) From one network to another a node is: the point of interconnection between the two networks including the interface.

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